



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 6  
1445 ROSS AVENUE, SUITE 1200  
DALLAS TX 75202-2733

**MEMORANDUM**

**SUBJECT:** Decision Document for the Time Critical Removal Action at the San Jacinto River Waste Pits Site, Harris County, Texas

**FROM:** Valmichael Leos, Remedial Project Manager  
Remedial Branch, LA/NM/OK Section (6SF-RL)

**THRU:** Charles Faultry, Associate Director  
Remedial Branch (6SF-R)

Mark Hansen, Associate Director  
Prevention and Response Branch (6SF-P)

**TO:** Samuel Coleman, P.E., Director  
Superfund Division (6SF)

**I. PURPOSE**

This Memorandum documents EPA's decision for selection of a removal option at the San Jacinto River Waste Pits site (the "site") located near Houston, Texas in the city of Baytown, Harris County, Texas (Attachment 1). On May 17, 2010, an administrative order on consent (AOC) was issued to the International Paper Company, Inc. and McGinnes Industrial Maintenance Corporation (the "PRPs") for a Time Critical Removal Action (TCRA) at the site. The PRPs were requested to submit a technical memorandum that will evaluate all removal option alternatives for the design and construction of a physical barrier surrounding waste ponds 1 and 2 that will temporarily abate the release or threat of release of dibenzo-p-dioxins and polychlorinated dibenzofurans into the San Jacinto River as outlined in the TCRA Memorandum dated April 2, 2010 (Action Memo). A final technical memorandum was submitted to EPA on June 15, 2010, for review and analysis.

**II. SITE CONDITIONS AND BACKGROUND**

CERCLIS ID#: TXN000606611  
Category of Removal: Time-Critical  
Site ID#: 06ZQ  
Latitude: 29.7944  
Longitude: -95.0625



A. Site Description & Environmental Threat

The site encompasses approximately 25 acres. The removal action is to stabilize the site by designing and constructing a physical protective barrier surrounding waste ponds 1 and 2 that temporarily abates the release of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (and possibly PCBs) into the San Jacinto River, until the site is fully characterized and a remedy is selected.

The Site, as indicated in Attachment 1, is in Harris County in the State of Texas. The Site itself has no specific street address. The Site is comprised of two waste ponds with three surface impoundments built in the 1960's. The ponds and impoundments are situated on a partially submerged 20-acre parcel of real property. The Site is located on the western bank of the San Jacinto River, in Harris County, Texas, immediately north of the Interstate Highway 10 (I-10) bridge over the San Jacinto River. Available information indicates the two waste ponds were built during 1965 by constructing berms within the estuarine area just north of what was then Texas State Highway 73 and is now I-10, west of the main river channel, east of the City of Houston, between two unincorporated areas known as Channelview and Highlands.

The waste paper sludge was placed in the two ponds on the Site. Waste pond 1 is located on the western portion of the Site totaling 132,386 square feet. Waste pond 2 which consists of two surface impoundments are on the eastern portion of the Site totaling 46,182 square feet and 188,641 square feet respectively. Currently, the Site is inactive and approximately half of the Site's surface area, including the abandoned waste disposal ponds, is now submerged below the adjacent San Jacinto River's water surface. Waste pond 1 with one impoundment is partially submerged and waste pond 2 with the two impoundments is completely submerged in the San Jacinto River.

The primary hazardous substances documented at the Site are polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans. At the time of the signing of the Action Memo, dioxin concentrations as high as 41,300 parts per trillion have been found in sediment samples collected from the Site's disposal pond areas and from river sediments near the Site. Sediments contaminated with high levels of dioxin have been found in the San Jacinto River both upstream and downstream from the Site due to tidal influences. Additional sediment samples were collected in compliance with the Action Memo, dioxin concentrations as high as 360,000 parts per trillion have been found in sediment samples collected from the submerged portion of the waste disposal ponds as well as dioxin concentrations as high as 3,660 parts per trillion action level in sediment samples collected outside the original 1966 berm placement for the two waste ponds indicating the release of dioxin from the original location of the waste ponds.

B. Release or Threatened Release into the Environment of a Hazardous Substance, or Pollutant or Contaminant

Concentrations higher than 330 parts per trillion of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans have been detected in sediment and surface water within the original 1966 boundaries of the waste ponds and within 100 feet of the waste ponds. Dioxins and furans are "hazardous substances" as defined by Section 101 (14) of CERCLA, 42 U.S.C. §9601 (14).



C. NPL Status

The Site was proposed for listing on the National Priorities List ("NPL") on September 19, 2007 (72 FR53509), and was placed on the NPL effective March 19, 2008 (73 FR 14719).

D. Maps, pictures and other graphic representations

Attachment 1 Site Map with Waste Pits 1 and 2

Attachment 2 April 2, 2010 TCRA memorandum

Attachment 3 June 15, 2010 Final RP TCRA technical memo

Attachment 4 Harris County technical memo comments

Attachment 5 Texas Commission on Environmental Quality technical memo comments

Attachment 6 HVJ Comments on Anchor QEA Draft Design Memoranda

E. Current Actions

On July 17, 2009, EPA sent a Special Notice Letter to the Respondents offering them an opportunity to negotiate and enter into an AOC covering the performance of the Remedial Investigation and Feasibility Study (RI/FS) of the Site. However, EPA never received a Good Faith Offer on which to begin negotiations of a RI/FS for the Site.

On November 20, 2009, EPA issued a Unilateral Administrative Order (UAO) to International Paper Company, Inc. and McGinnes Industrial Maintenance Corporation to conduct a RI/FS to study the nature and extent of contamination at the site.

On April 2, 2010, EPA determined an imminent and substantial (ISE) endangerment to public health and the environment at the San Jacinto River Waste Pits Superfund Site for the threat and actual release of dioxin into the San Jacinto River and issued a time critical removal action (TCRA) memorandum.

On May 17, 2010, EPA entered an AOC with International Paper Company, Inc. and McGinnes Industrial Maintenance Corporation to conduct a time critical removal action to temporarily address the release of dioxin into the San Jacinto River, until the nature and extent of contamination at the site is being fully characterized and a remedy is selected.

### **III. TCRA MEMORANDUM**

A. Proposed Actions & Performance Criteria

The proposed action for the April 2, 2010, Action Memo (see Attachment 2) involves the immediate design and construction of a physical protective barrier surrounding waste ponds 1 and 2 that temporarily addresses the release or threat of release of dibenzo-p-dioxins and polychlorinated dibenzofurans into the San Jacinto River, until the site is fully characterized and a remedy is selected.

Sampling was conducted within the original 1966 berm and the area immediately surrounding the original 1966 berm line surrounding waste pit 1 and 2. Any concentrations

greater than or equal to 330 ng / kg of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) organic carbon normalized (or 4.5 ng / kg TCDD non-organic carbon normalized) in the sediment found within the original 1966 berm will be considered part of the source area of contamination that must be addressed with the protective barrier. Any concentrations of less than 330 ng / kg of TCDD organic carbon normalized (or 4.5 ng / kg TCDD non-organic carbon normalized) found in the sediment will be addressed in future non-time critical or remedial actions at the site.

The barrier design and construction must be structurally sufficient to withstand forces sustained by the river including any future erosion and be structurally sound for a number of years until a final remedy is designed and implemented. Also, the Houston area is visited by seasonal severe weather events (i.e., strong force winds or flooding) and the physical protective barrier must be structurally secure to withstand any potential future extreme weather events (i.e., Hurricane Ike of 2008).

#### B. Performance Requirements

Evaluation of the TCRA alternatives for temporary abatement of actual releases of dioxin into the San Jacinto River, until the site is fully characterized and a remedy is selected, considered the following performance criteria in the TCRA memo dated April 2, 2010:

1. Temporarily abate the release and threat of release of dioxin from the waste ponds built in 1966 into the San Jacinto River until the site is fully characterized and a remedy is selected.
2. Control erosion of waste materials from upland runoff, heavy rains, river and tidal currents, waves, and propeller wash and be structurally stable for five to seven years until the site is fully characterized and a remedy is selected.
3. The ability of the TCRA alternative to withstand and remain in place and effective during and after extreme weather events for five to seven years while the nature and extent of contamination is being investigated. Elements in the Operations and Maintenance plan will require compliance monitoring after designated weather events to ensure performance requirements are being met for the selected removal.
4. Minimize negative impacts resulting from the TCRA alternative on river navigation or flood control ensuring that the sediments surrounding the waste ponds are not affected until the nature and extent of contamination of the site is fully characterized and a remedy is selected.

### IV. **PROPOSED TCRA ALTERNATIVES ANALYSIS**

#### A. Proposed Alternative Descriptions

In accordance with requirements in the May 17, 2010, TCRA AOC, the responsible parties submitted a technical memorandum providing an analysis of various TCRA alternative design options available that temporarily abates the release of dioxin into the San Jacinto River that poses an imminent and substantial endangerment as specified in the TRCA Memo. Five



alternatives were identified by the responsible parties and are summarized below. A detailed analysis of each alternative is provided in the document *Revised draft time critical removal action alternatives analysis San Jacinto River Waste Pits superfund site* (see Attachment 9).

Alternative 1: Sheet Pile & Granular Cover

- This alternative would involve the use of sheet piling (steel or composite) as physical barrier placed along the 1966 berm location (eastern and western portion) that would temporarily act as a physical barrier isolating the waste pits from the San Jacinto River. In addition, a granular cover consisting of appropriately designed sand, gravel, or rock would be used to contain and prevent contaminated waste and sediment from contaminating the environment. Estimated cost and construction time for alternative 1 is approximately \$5.8 million dollars and take six months to complete.

Alternative 2: Sheet Pile, Granular Cover, Dredge, & Revetment

- This alternative would involve the use of sheet piling (steel or composite) as a temporary physical barrier placed along the 1966 berm location (western portion) that would act as a physical barrier isolating the waste pits from the San Jacinto River. Dredging will be conducted along the northwestern portion of the waste pits in combination with the use of rock revetment along the perimeter of the waste pits for containment stability. In addition, a granular cover consisting of appropriately designed sand, gravel, or rock would be used to contain and prevent contaminated waste and sediment from contaminating the environment. Estimated cost and construction time for alternative 2 is approximately \$5.1 million dollars and will take five months to complete.

Alternative 3: Granular cover and revetment

- This alternative would involve the use of a granular cover consisting of appropriately designed sand, gravel, or rock would be used to temporarily contain and prevent contaminated waste and sediment from contaminating the environment. Sheet piling is not being used along the perimeter of the waste pits for containment instead a rock berm will be used to isolate the waste pits from the San Jacinto River. Estimated cost and construction time for alternative 3 is approximately \$3.6 million dollars and will take three months to complete.

Alternative 4: Rock berm, granular cover, and revetment

- This alternative is a hybrid of alternative 3 and would use a granular cover along the eastern waste pit and partial granular cover along with a geotextile cover in the western waste pit area. Estimated cost and construction time for alternative 4 is approximately \$4.0 million dollars and will take three months to complete.

Alternative 5: ACBM and dredge

- This alternative would involve the use of an Articulated Concrete Block Matt (ACBM) technology that would be layered over the eastern and western waste pits used to contain and prevent contaminated waste and sediment from further contaminating the environment. A rock submerged rock scour apron will be used along the perimeter of the waste pits to isolate contamination from the San Jacinto River. Estimated cost and construction time for alternative 5 is approximately \$7.0 million dollars and take three months to complete.



## B. Proposed TCRA Alternative Concerns

Each alternatives listed above have advantages and disadvantages that must be considered when choosing the most appropriate option that will satisfy the Imminent and Substantial Endangerment (ISE) determination specified in the TCRA memo. Site specific concerns have been submitted to EPA from Harris County (see Attachment 4) and the Texas Commission on Environmental Quality, (see Attachment 5) with regards to the alternatives proposed by the responsible parties. A summary of all concerns raised from the county and state, other stakeholders are summarized below.

- Minimize public health and environmental threat from site contamination.
- Prevent spread and movement of site contamination.
- Storm event design number used for cover material calculation.
- Prevent impacts from flooding upstream and scouring on I-10 bridge downstream which may result from TCRA construction.
- Use of a combination of technologies (i.e. removal w/ containment).

## V. **PREFERRED TCRA ALTERNATIVE OPTION**

### A. Preferred Option: TCRA Alternative 3

All five alternatives temporarily abate the release and threat of release of dioxin from the 1966 waste ponds into the San Jacinto River that present an imminent and substantial endangerment. Although all five alternatives address the ISE stated in the April 2, 2010, Action Memo, Alternative 3 (see Attachment 3) is the best option for temporary containment and source control. Alternative 3 best minimizes the hydrological impact to the San Jacinto River from the waste ponds and reduces migration of contaminated dioxin sediments in the waste ponds until the nature and extent of contamination is determined and a final remedy is selected.

Alternatives 1, 2, and 4 all have large barriers around the perimeter of the eastern or western waste ponds that reduces the cross section of the river channel and impinges the natural river flow during flood stage events which increases likelihood of river scour downstream and negatively impacts areas where contaminated dioxin sediments migrate from the waste ponds. Alternatives 3 and 5 are the least disruptive in changing the river cross section and risk of negatively impacting the areas where contaminated dioxin sediments may migrate from the waste ponds.

Due to the temporary nature of the TCRA; alternative 3 best addresses the temporary release of dioxins from the waste ponds into the San Jacinto River rather than alternative 5. Alternative 3 uses a combination of granular cover material such as sand, gravel, and rock, while alternative 5 uses an articulated block mat (ACBM) technology. Alternative 3 is better suited as a temporary measure because it offers more flexibility in choosing a future remedy at the site, while alternative 5 uses a more permanent cover material which is more difficult to remove than alternative 3, and thus reduce the flexibility in the selection of a future remedy.



B. Modification to Proposed TCRA Alternative 3

A modified version of TCRA alternative number three proposed by the respondents in the June 15, 2010, Technical Memo (Attachment 3) will best temporarily abate the release of dioxin into the San Jacinto River that poses an imminent and substantial endangerment outlined in the TCRA memo and is the preferred alternative for immediate design and construction. The two modifications involve 1) the change of the design storm event calculation and 2) encourage the use of a geomembrane instead of a geotextile fabric technology for use underneath granular cover that will minimize or prevent movement of contaminants as colloids and diffusive loss of pore water preventing benthic and human contact.

Currently, the respondents are proposing to use a granular cover material sized and corresponding gradation to resist a 10 year return interval flow design storm event (see Appendix A, Attachment 3) for the cover on top of the waste pits to ensure containment. After consideration from comments received from Harris County (Attachment 4), TCEQ (Attachment 5), and independent review from a licensed professional engineer contracted by the EPA (see Attachment 6) a 10 year design storm event being proposed for alternative 3 is inappropriate.

TCRA performance measures are dependent upon the overall stability of the surrounding channel. Moreover, the performance measures are dependent upon the overall surrounding system of the channel, therefore alternative 3 cover material should utilize a design that considers storm events with a return period of 100 years. The TCRA design should follow design criteria specified by the 1994 U.S. Army Corps of Engineers document named "EM 1110-2-1601 entitled "Hydraulic Design of Flood Control Channels."

While the first modification for change of the design storm number to a 100 year return period is required; the second modification, is optional, but highly encouraged due to concerns of movement of contaminates as colloids.


C. Preferred TCRA Alternative

This decision document represents the preferred removal option of alternative 3, with the above stated modifications, for the implementation of the TCRA at San Jacinto River Waste Pits site near Houston, Harris County, Texas, is developed in accordance with CERCLA, 42 U.S.C. § 9601 *et seq.*, and consistent with the NCP, 40 CFR § 300. In addition, the implementation of an EPA approved TCRA alternative 3 O&M plan will detail the need for additional environmental sampling and monitoring to ensure performance requirements are being met for the selected removal option alternative. This decision is based on the administrative record for the site.



Conditions at the site meet the NCP section 300.415(b)(2) criteria for the removal alternative and I recommend your approval of the preferred removal action alternative option stated above. No funding will come from the Regional removal allowance for this preferred removal action alternative option.

Approved:

  
Samuel Coleman, P.E., Director  
Superfund Division

Date: 7/28/10

Attachments



## Reference List

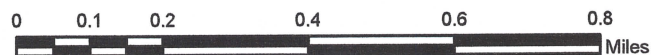
USACE. 1994. *Hydraulic Design of Flood Control Channels*. U.S. Army Corps of Engineers.  
Document No. EM 1110-2-1601



Figure 1 - Site Location Map



SOURCE - The base data used are the Highlands Digital Orthoquarter Quadrangles (DOQQs), which are digital versions of aerial photographs. This DOQQ was produced by the TCEQ using USGS guidelines.  
NAD 83 UTM Zone 15.







UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 6  
1445 ROSS AVENUE, SUITE 1200  
DALLAS TX 75202-2733

APR 02 2010

**MEMORANDUM**

**SUBJECT:** Request for a Time Critical Removal Action at the San Jacinto River Waste Pits Site, Harris County, Texas

**FROM:** Valmichael Leos, Remedial Project Manager (RPM)  
Remedial Branch, LA/NM/OK Section (6SF-RL) *[Signature]*

**THRU:** Charles Faultry, Associate Director  
Remedial Branch (6SF-R) *[Signature]*  
Mark Hansen, Associate Director  
Prevention & Response Branch (6SF-P) *[Signature]*

**TO:** Samuel Coleman, P.E., Director  
Superfund Division (6SF)

**I. PURPOSE**

This Memorandum requests approval of a Time Critical removal action in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. § 9604, at the San Jacinto River Waste Pits site (the "site"). The Site is located east of the City of Houston between two unincorporated areas known as Channelview and as Highlands (Attachment 1). The removal action is to stabilize the site, temporarily abating the release of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (and possibly PCBs) into the waterway, until the site is fully characterized and a remedy is selected.

This action meets the criteria for initiating a removal action under Section 300.415 of the National Oil and Hazardous Substances Contingency Plan (NCP), 40 CFR § 300.415. This action is expected to require less than twelve months to complete.

**II. SITE CONDITIONS AND BACKGROUND**

CERCLIS ID#: TXN000606611  
Category of Removal: Time-Critical  
Site ID#: 06ZQ  
Latitude: 29.7944  
Longitude: -95.0625



A. Site Description

1. Removal Site Evaluation

In July 2005, seven samples were collected from the Tract of land located on the site for the U.S. Environmental Protection Agencies' (EPA's) Hazard Ranking System Documentation Record report (HRS Report). Each sample was found to contain a combination of the following chemicals, also known as, dioxin congeners. From these seven samples (USEPA UAO 2009), the highest detected concentration of each dioxin / furan congener include:

| Congener                               | parts per trillion (PPT)<br>or nanogram per<br>kilogram (ng/kg) | Sample<br>location |
|--|---|--------------------|
| 2,3,7,8-Tetrachlorodibenzo-p-dioxin    | 18,500  | SE-08              |
| 1,2,3,7,8-Pentachlorodibenzodioxin     | 363   | SE-09              |
| 1,2,3,4,7,8-Hexachlorodibenzodioxin    | 4.83  | SE-09              |
| 1,2,3,6,7,8-Hexachlorodibenzodioxin    | 28  | SE-09              |
| 1,2,3,7,8,9-Hexachlorodibenzodioxin    | 10  | SE-09              |
| 1,2,3,4,6,7,8-Heptachlorodibenzodioxin | 658   | SE-09              |
| 2,3,7,8-Tetrachlorodibenzofuran        | 41,300  | SE-08              |
| 1,2,3,7,8-Pentachlorodibenzofuran      | 3,770   | SE-IO              |
| 2,3,4,7,8-Pentachlorodibenzofuran      | 2,330   | SE-IO              |
| 1,2,3,4,7,8-Hexachlorodibenzofuran     | 8,660   | SE-IO              |
| 1,2,3,6,7,8-Hexachlorodibenzofuran     | 2,290   | SE-IO              |
| 2,3,4,6,7,8-Hexachlorodibenzofuran     | 349   | SE-IO              |
| 1,2,3,7,8,9-Hexachlorodibenzofuran     | 656   | SE-IO              |
| 1,2,3,4,6,7,8-Heptachlorodibenzofuran  | 2,360   | SE-IO              |
| 1,2,3,4,7,8,9-Heptachlorodibenzofuran  | 878   | SE-IO              |

A recent site visit by EPA Remedial Project Managers Leos and Tzhone on Monday March 1, 2010, documented grayish waste entering the San Jacinto River along the Northwest corner of the site from waste pond 1 (Attachment 3). In addition, 95% of Waste pond #2 was observed to be under four feet of water. Waste pond 2 consisting of two surface impoundments is continually inundated by the San Jacinto River and contaminated sediment within the source area and is in direct contact with the river water as documented in the December 1987, December 1989, February 1992, April 1998, June 1999, May 2002, February 2003, and April 2005 aerial photographs of the Tract (Attachment 6).

There is no containment to prevent the migration of hazardous substances from the waste ponds into the San Jacinto River. Chemical analysis confirms that dioxin and dibenzofuran contaminants are entering the San Jacinto River. Chemical analysis documented the presence of numerous dioxin congeners in the source sediments. In addition, sediment samples collected within the surface waste ponds indicate that concentrations of hazardous substances are present at levels significantly greater than upstream and downstream background levels and in concentrations greater than the corresponding by Contract-Required Quantitation Levels.

## 2. Physical Location

The Site, as indicated in Attachment 1, is in Harris County in the State of Texas. The Site itself has no specific street address. The Site is comprised of an area of land with a set of two waste ponds with three surface impoundments built in the 1960s for disposal of pulp and paper mill wastes. The site is located on a 20-acre parcel on the western bank of the San Jacinto River, in Harris County, Texas, immediately north of the Interstate Highway 10 (I-10) bridge over the San Jacinto River. Prior to 1965, the two waste ponds were built by constructing berms within the estuarine marsh just north of what was then Texas State Highway 73 and is now I-10, west of the main river channel east of the City of Houston between two unincorporated areas known as Channelview and Highlands.

## 3. Site Characteristics

The Site consists of two waste ponds consisting of three surface impoundments containing hazardous substances partially submerged in the San Jacinto River as well as locations those hazardous substances have been deposited, placed, or otherwise come to be located. Aerial photographs as early as the 1970s indicate the Tract inundated by the San Jacinto River. The ponds at the Site are connected with a drain line to allow flow of excess water (including rain water) from Pond #1 on the western side, to Pond #2 on the eastern side. Both ponds were used as a waste disposal area and waste was pumped into the impoundments from the barge as a slurry (Attachment 2). The outer edges of the eastern pond collected the effluent from the western impoundment where it was transported back to the Champion paper mill in Pasadena, Texas, where is passed through subsequent settling ponds. There is evidence of a secondary impoundment in the eastern pond that may have been associated with the drain line between the two waste ponds.

The waste paper sludge was placed in the two ponds on the Tract. Waste pond 1 is located on the western portion of the Tract totaling 132,386 square feet. Waste pond 2 which consists of two surface impoundments are on the eastern portion of the Tract totaling 46,182 square feet and 188,641 square feet respectively. Currently, the Tract is inactive and approximately half of the Tract's surface area, including the abandoned waste disposal ponds, is now submerged below the adjacent San Jacinto River's water surface.

The primary hazardous substances documented at the Site are polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans. Dioxin concentrations as high as 41,300 parts per trillion have been found in sediment samples collected from the Tract's disposal pond areas and from river sediments near the Tract. Sediments contaminated with high levels of dioxin have been found in the San Jacinto River both upstream and downstream from the Tract due to tidal influences.

## 4. Release or Threatened Release into the Environment of a Hazardous Substance, or Pollutant or Contaminant



Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans have been detected in sediment and surface water at the site. Dioxins and furans are "hazardous substances" as defined by Section 101(14) of CERCLA, 42 U.S.C. §9601(14).

5. NPL Status

The Site was proposed for listing on the National Priorities List ("NPL") on September 19, 2007 (72 FR53509), and was placed on the NPL effective March 19, 2008 (73 FR 14719).

6. Maps, pictures and other graphic representations

- Attachment 1 Current Site Location
- Attachment 2 Site Map with Waste Pits 1 and 2
- Attachment 3 Site photos of waste entering San Jacinto River dated 03/01/2010
- Attachment 4 ATSDR Fact Sheets on Dioxins/Furans
- Attachment 5 Enforcement Addendum (Enforcement Confidential/FOIA Exempt)
- Attachment 6 Historical Aerial photos of site
- Attachment 7 1966 Datum Map with original impoundments line superimposed

B. Other Actions to Date

1. Previous Actions

On December 27, 1965, the Harris County Health Department ("HCHD") observed liquid waste being pumped out of a pond at the Tract directly into the San Jacinto River. On December 28, 1965, the HCHD sent a letter to MIMC and Champion ordering them to stop discharging "black liquor" from the waste ponds into the San Jacinto River. In addition, the HCHD demanded that the levees surrounding the wastes ponds be repaired.

A December 30, 1965 internal Champion memo confirmed that water seepage was occurring along the waste ponds' levees and two sections of the levee around the western waste pond.

In May 1966, the Texas Department of Health ("TDH") investigated Champion Paper's waste disposal practices. The TDH noted seepage on the western waste pond and needed improvements on the eastern waste ponds because it had never been properly completed even though waste was being stored near capacity within its confines. In addition, the TDH noted that storm events had the potential to cover the disposal area with water and wash out the levees.

On July 29, 1966, the Texas Water Pollution Control Board ("TWPCB") granted MIMC permission to release a combination of stabilized waste water and rain water from the waste ponds into the San Jacinto River. The TWPCB noted that the waste ponds would no longer be used for the storage of waste material.

The City of Houston conducted a toxicity study of the Houston Ship Channel including the San Jacinto River published in July 1995. Samples of sediment and fish and crab samples were collected in August 1993 and May 1994 for the study. Sediment samples collected northeast of the Tract indicated extremely high dioxin and furan levels. These dioxin and furan levels were the highest values recorded in the entire Houston Ship Channel. In addition, fish and crab samples collected northeast of the Tract and 1 mile downstream from the Tract also indicated extremely high levels of dioxins and dibenzofurans.

In January 2004, the Texas Commission on Environmental Quality ("TCEQ") published a study of the Total Maximum Daily Loads ("TMDLs") for Dioxins in the Houston Ship Channel. Samples of sediment and fish tissue were collected in summer 2002, fall 2002, and spring 2003. The data collected indicated the continued presence of dioxin contamination in the San Jacinto River surrounding the Tract. In addition, the fish and shellfish tissue samples collected indicated that the health-based standard was exceeded in 97% of fish samples and in 95% of the crab samples. Additional samples in the San Jacinto River surrounding the Tract were collected in spring 2004 and confirmed the high dioxin concentrations.

On April 14, 2005, the Texas Parks & Wildlife Department ("TPWD") referred the area consisting of the Tract to the U.S. EPA for evaluation under the Hazardous Ranking System as a potential Superfund site. The TPWD submitted a 1982 topographic map and aerial photographs of the Tract indicating much of the land area has been submerged due to subsidence. In addition, the TPWD cited the Houston Ship Channel Toxicity Study and the TMDLs for Dioxins in the San Jacinto River as indication that there was a risk that needed to be addressed at the Tract due to the unusually high dioxin readings collected northeast of the Tract as well as downstream from the Tract.

## 2. Current Actions

On July 17, 2009, EPA sent a Special Notice Letter to the Respondents offering them an opportunity to negotiate and enter into an Administrative Order on Consent ("AOC") covering the performance of the Remedial Investigation and Feasibility Study (RI/FS) of the Site. However, EPA never received a Good Faith Offer to perform the RI/FS for the Site.

On November 20, 2009, EPA issued a Unilateral Administrative Order (UAO) to International Paper Company, Inc. and McGinnes Industrial Maintenance Corporation to conduct a RI/FS to study the nature and extent of contamination at the site.

## C. State and Local Authorities' Roles

### 1. State and Local Actions to Date

In August 2009, the TCEQ conducted environmental sampling to evaluate releases from the pits into surface water and sediments at the site. A final report will be available for review in the 3<sup>rd</sup> fiscal quarter of 2010.



## 2. Potential for State/local Response

The TCEQ, Harris County, along with other federal stakeholders (i.e. US Fish and Wildlife Service and the National Oceanic and Atmospheric Administration) will provide technical assistance to the EPA during oversight of this removal action.

### **III. THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT, AND STATUTORY AND REGULATORY AUTHORITIES**

#### **A. Threats to Public Health or Welfare**

Section 300.415 of the NCP lists the factors to be considered in determining the appropriateness of a removal action. Paragraphs (b)(2)(i), (iii), (iv), and (v) directly apply to the conditions at the site. Any one of these factors may be sufficient to justify a removal action.

##### **1. Exposure to Human Populations, Animals or the Food Chain, NCP Section 300.415.(b)(2)(i)**

There is potential for exposure of human populations and animals to dibenzo-p-dioxins and polychlorinated dibenzofurans, which are hazardous substances as defined in CERCLA Section 101(14), 42 U.S.C. 9601(14), and further defined at 40 CFR § 302.4. A release of these contaminants from both waste ponds has been identified through site assessment activities conducted by EPA and TCEQ in 2006, and there is a threat of further release. Site assessment activities included surface water and sediment sampling for the presence of dioxins and furans. People and animals coming on to the site could be exposed to these contaminants through ingestion, skin contact and inhalation pathways. In addition, during a recent site visit conducted on March 1, 2010, by RPMs Leos and Tzhone, releases of hazardous substances were observed entering the San Jacinto River from both Waste ponds #1 and #2.

Routes of exposure include, but are not limited to: human direct dermal contact with contaminated sediment or water; human ingestion of contaminated sediment or water; human inhalation of contaminated sediment or water; human direct dermal contact with contaminated ecological receptors; human ingestion of contaminated ecological receptors; and ecological bioaccumulation of contaminants at every level of the food web.

Both human and ecological health is threatened by releases of hazardous substances from the Tract. Humans trespass on and around the site to capture ecological receptors for sport and subsistence. Ecological receptors include, but are not limited to: fish, birds, mammals, amphibians, reptiles, macro-invertebrates, micro-invertebrates, and plants. Ecological health is also threatened by bioaccumulation of hazardous substances released from the north tract/source area at every level of the food chain.

Dioxins from natural and anthropogenic (man-made) sources have been widely distributed throughout the environment. Almost every living creature has been exposed to

dioxins. Studies have shown that exposure to dioxins at high enough doses may cause a number of adverse health effects.

The most common health effect in people exposed to large amounts of dioxins, in particular 2,3,7,8- Tetrachlorodibenzo-p-dioxin (2,3,7,8,-TCDD), is chloracne. Chloracne cases have typically been the result of accidents or significant contamination events. Chloracne is a severe skin disease with acne-like lesions that occur mainly on the face and upper body. Other skin effects noted in people exposed to high doses of 2,3,7,8-TCDD include skin rashes, discoloration, and excessive body hair. Changes in blood and urine that may indicate liver damage also are seen in people. Exposure to high concentrations of CDDs may induce long-term alterations in glucose metabolism and subtle changes in hormone levels.

In certain animal species, 2,3,7,8-TCDD is especially harmful and can cause death after a single exposure. Exposure to lower levels can cause a variety of effects in animals, such as weight loss, liver damage, and disruption of the endocrine system. In many species of animals, 2,3,7,8-TCDD weakens the immune system and causes a decrease in the system's ability to fight bacteria and viruses. In other animal studies, exposure to 2,3,7,8-TCDD has caused reproductive damage and birth defects. Some animal species exposed to TCDDs during pregnancy had miscarriages and the offspring of animals exposed to 2,3,7,8-TCDD during pregnancy often had severe birth defects including skeletal deformities, kidney defects, and weakened immune responses. Several studies suggest that exposure to 2,3,7,8-TCDD increases the risk of several types of cancer in people. Animal studies have also shown an increased risk of cancer from exposure to 2,3,7,8-TCDD.

The U.S. Department of Health and Human Services has determined that 2,3,7,8-TCDD may reasonably be anticipated to cause cancer and the World Health Organization has determined that 2,3,7,8-TCDD is a human carcinogen. EPA has classified hexachlorodibenzo-p-dioxin as a probable human carcinogen (B2).

2. Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers, that may pose a threat of release, NCP Section 300.415(b)(2)(iii)

Currently, the site consists of two waste ponds (Attachment 2) containing three surface impoundments. Waste pond #1 containing one of the surface impoundments is currently being eroded by the San Jacinto River and the contents of the ponds are being released into the waterway. Sampling of waste pond #1 confirms the presence of dibenzo-p-dioxins and polychlorinated dibenzofurans with concentrations ranging from 513 ng/kg to 23,300 ng/kg (WHO 2005). Waste pond #2 which contains two of the three surface impoundments and is located on the eastern site of the property is partly submerged under water and is releasing hazardous substances into the adjacent San Jacinto River. Sediment sampling in waste pond #2 has confirmed the presence of dibenzo-p-dioxins and polychlorinated dibenzofurans with concentrations ranging from 83 ng/kg to 34,000 ng/kg (WHO 2005).



3. Contaminants in Soils, NCP Section 300.415.(b)(2)(iv)

Dibenzo-p-dioxins and polychlorinated dibenzofurans are hazardous substances as defined in CERCLA Section 101(14), 42 U.S.C. § 9601(14), and further defined in 40 CFR § 302.4. Sample results indicated that dibenzo-p-dioxins and polychlorinated dibenzofurans contamination have exceeded 1,000 ng/kg in sediment samples collected from the impoundments as high as 34,000 ng/kg in waste pond #2 and as high as 23,300 ng/kg in waste pond #1.

4. Weather Conditions That May Cause the Release or Migration of Hazardous Substances, NCP Section 300.415(b)(2)(v)

The area receives an average of 50 inches of rain annually. The contaminants are subject to migration by entrainment, windblown deposition and surface runoff. The impoundments in waste ponds 1 and 2 may be affected by tides, winds, waves, and currents resulting from extreme weather conditions such as strong storm winds, flooding, tornadoes, and hurricanes which may cause a potential release or migration of dioxin and furan contaminated materials

B. Threats to the Environment

The levels of dibenzo-p-dioxins and polychlorinated dibenzofurans in sediment and surface water at this site in both waste ponds present a potential health problem to animal life that comes into contact with contaminated sediment and to freshwater aquatic life that receives runoff from this site.

#### IV. ENDANGERMENT DETERMINATION

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Action Memorandum, may present an imminent and substantial endangerment to public health, or welfare, or the environment.

#### V. PROPOSED ACTIONS AND ESTIMATED COSTS

A. Proposed Actions

1. Proposed Action Description

According to sediment and surface water samples taken by the TCEQ, EPA, and the University of Houston from 2005 through 2009 at the site, there are currently uncontrolled releases of dibenzo-p-dioxins and polychlorinated dibenzofurans into the San Jacinto River from Waste ponds #1 and #2. In addition to sampling data confirming releases from Waste ponds #1 and #2, a recent site inspection conducted in March 1, 2010, by Remedial Project Managers Leos and Tzhone has shown that there is visual evidence of grayish waste releasing into the San Jacinto River located in the Northwest corner of waste pond #1 (See Attachment 3). In addition, Waste pond #2 with its contaminated sediment, was observed to be under four feet of water and is continually releasing hazardous substances into the San Jacinto River.

The proposed action for this time critical removal involves the immediate design and construction of a physical protective barrier surrounding waste ponds 1 and 2 that address the release or threat of release of dibenzo-p-dioxins and polychlorinated dibenzofurans into the San Jacinto River. In addition to a physical protective barrier to keep the waste secure, there is currently unrestricted public access at the site. Public access restrictions must be put in place immediately following the approval of this action memorandum. The public access restrictions should involve placement of security fences and signs to prevent trespassing onto the property. The security fencing will prevent access of unauthorized persons into the entire area containing the waste impoundments.

Currently, there is not sufficient data available to fully characterize the nature and extent of contamination from waste ponds 1 and 2 (Attachment 2). Additional sediment and surface water samples need to be taken immediately for the design and construction of the protective barrier. A sampling plan will be prepared and implemented immediately following the approval of this action memorandum from which environmental sampling will occur along the perimeter of the referenced 1966 dike alignment shown in Attachment 7. Any concentrations greater than or equal to 330 ng / kg of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) organic carbon normalized (or 4.5 ng / kg TCDD non-organic carbon normalized) in the sediment will be considered part of the source area of contamination within the original 1966 berm placement as shown in Attachment 7 that must be addressed with the protective barrier. Any concentrations of less than 330 ng / kg of TCDD organic carbon normalized (or 4.5 ng / kg TCDD non-organic carbon normalized) found in the sediment will be addressed in future non-time critical or remedial actions at the site.

The barrier design and construction must be structurally sufficient to withstand forces sustained by the river including any future erosion and be structurally sound for a number of years until a final remedy is designed and implemented. Also, the Houston area is visited by seasonal severe weather events (i.e. strong force winds or flooding) and the physical protective barrier must be structurally secure to withstand any potential future extreme weather events (i.e. Hurricane Ike of 2008).

All requirements under the OSHA of 1970, 29 U.S.C. § 651 et seq., and under the laws of a State with an approved equivalent worker safety program, as well as other applicable safety and health requirements, will be followed. Federal OSHA requirements include, among other things, Hazardous Materials Operation, 20 CFR § 1910, as amended by 54 Fed. Reg. 9317 (March 1989), all OSHA General Industry (29 CFR § 1910) and Construction (29 CFR § 1926) standards wherever they are relevant, as well as OSHA record keeping and reporting regulations, and the EPA regulations set forth in 40 CFR § 300 relating to the conduct of work at Superfund sites.

## 2. Contribution to Remedial Performance

Because this action constitutes source control, these actions are consistent with any long term remediation strategies that may be developed for the site.

### 3. Description of Alternative Technologies

Alternative technologies will be evaluated at a future date after the site stabilization and source control have been achieved.

### 4. Applicable or Relevant and Appropriate Requirements (ARARs)

This removal action will be conducted to abate the actual or potential release of a hazardous substance, pollutant, or contaminant to the environment, in accordance with CERCLA, 42 U.S.C. § 9601 *et seq.*, and in a manner consistent with the National Contingency Plan, 40 CFR § 300, as required in 33 U.S.C. § 1321(c)(3) and 42 U.S.C. § 9604 (a)(1). As stated in 40 CFR § 300.415(j), fund-financed removal actions under CERCLA Section 104 and removal actions under CERCLA Section 106 shall, to the extent practicable considering the exigencies of the situation, attain the ARARs under Federal environmental law. ARARs are set forth in the TSCA codified in 40 CFR § 700 for the disposal, cleanup and verification sampling of PCBs spills.

The RCRA waste analysis requirements found in 40 CFR § 261.20 and 261.30, RCRA's manifesting requirements found in 40 CFR § 262.20, and RCRA packaging and labeling requirements found in 40 CFR § 262.30 are ARARs for this removal action. Because onsite storage of hazardous wastes will not exceed ninety days, specific storage requirements found in 40 CFR § 265 are not ARARs. *See* 40 CFR § 262.34.

### 5. Project Schedule

After the Action Memorandum is signed, it is anticipated that the additional sampling for design along with the construction will commence within 60 days. Onsite construction will take approximately 90 to 120 days to complete. Total project length will be approximately 180 days.

## **VI. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN**

The proposed actions for the San Jacinto River Waste Pits site should be taken immediately. Should these actions be delayed, the potential threats to human health and the environment will increase. A substantial amount of the dibenzo-p-dioxins and polychlorinated dibenzofurans waste will continue to release and spread into the San Jacinto River and unrestricted access to the area will continue to threaten nearby human populations.

## **VII. OUTSTANDING POLICY ISSUES**

None.

## **VIII. ENFORCEMENT**

*See* attached confidential Enforcement Attachment (*See* Attachment 5).

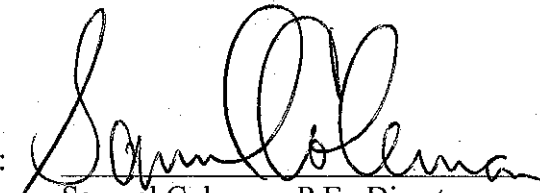


## IX. RECOMMENDATION

This decision document represents the selected removal action for the San Jacinto River Waste Pits site near Houston, Harris County, Texas, is developed in accordance with CERCLA, 42 U.S.C. § 9601 et seq., and consistent with the NCP, 40 CFR § 300. This decision is based on the administrative record for the site.

Conditions at the site meet the NCP section 300.415(b)(2) criteria for a removal and I recommend your approval of the proposed removal action. No funding will come from the Regional removal allowance for this proposed action.

Approved:

  
Samuel Coleman, P.E., Director  
Superfund Division

Date:

2 April 2010

Attachments

## Reference List

U.S. EPA. 2009. *Unilateral Administrative Order for Remedial Investigation / Feasibility Study*. U.S. EPA Region 6. CERCLA Docket No. 06-03-10

TCEQ and U.S. EPA. 2006. *Screening Site Assessment Report San Jacinto River Waste Pits, Channelview, Harris County, Texas*. TXN000606611. Texas Commission on Environmental Quality and U.S. Environmental Protection Agency.

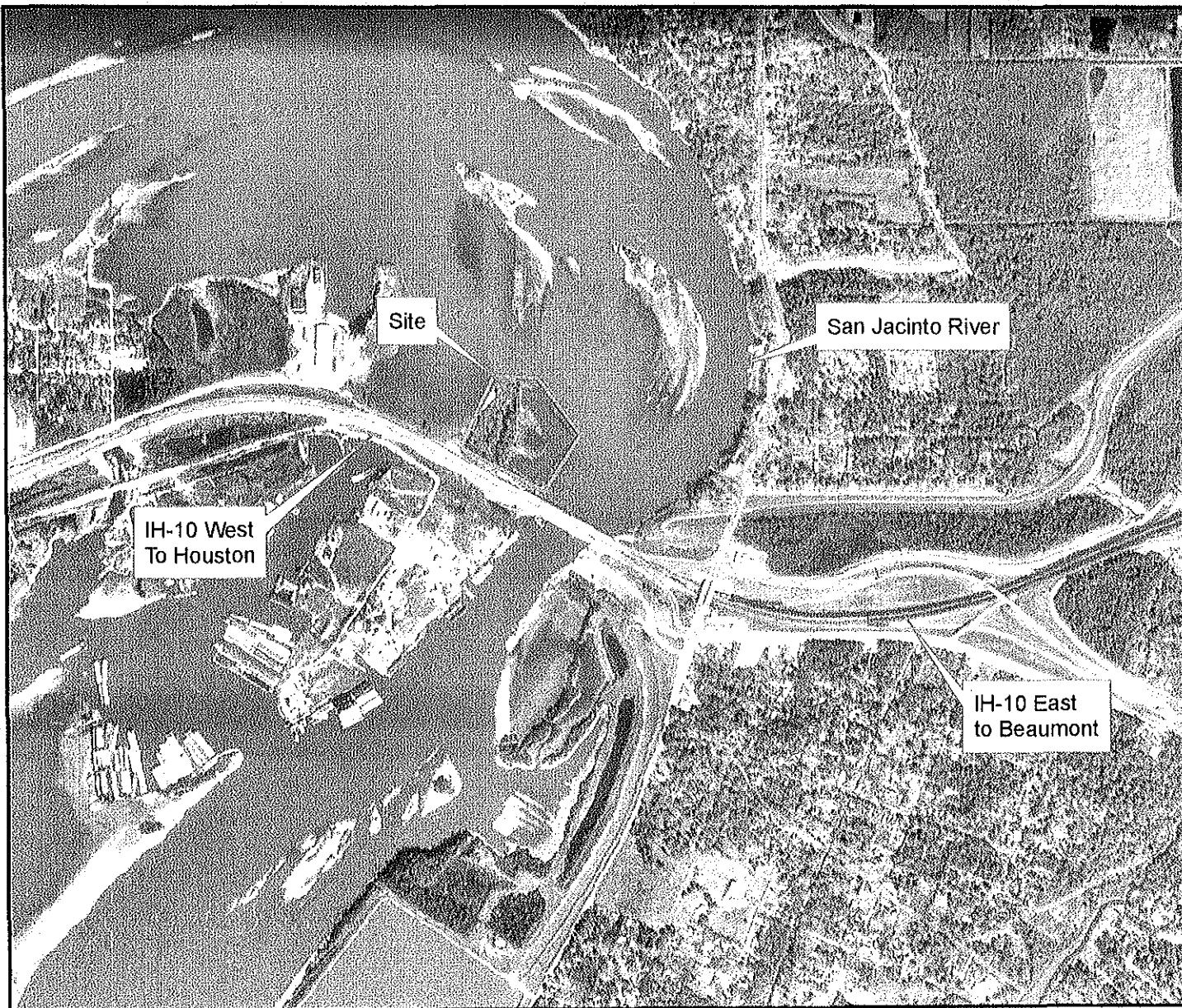
University of Houston and Parsons. 2006. *Total maximum daily loads for dioxins in the Houston Ship Channel*. Contract No. 582-6-70860, Work Order No. 582-6-70860-02. Quarterly report No. 3., Prepared in cooperation with the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency. University of Houston and Parsons Water & Infrastructure.  
<http://www.tceq.state.tx.us/assets/public/implementation/water/tmdl/26hscdioxin/26-all-data-compiled-q3-fy06.pdf>.

Weston. 2006. *Draft Field Activities Report for Sediment Sampling*. San Jacinto River Bridge Dolphin Project IH-10 at the San Jacinto River. Prepared for the Texas Department of Transportation, Environmental Affairs Division, Austin, TX. Weston Soutions, Inc., Houston, Texas.

**Attachment 1**  
**Current Site Location**



95 012



SOURCE - The base data used are the Highlands Digital Orthoquarter Quadrangles (DOQQs), which are digital versions of aerial photographs. This DOQQ was produced by the TCEQ using USGS guidelines.  
NAD 83 UTM Zone 15.




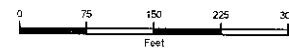
**Attachment 2**

**Site Map with Waste Pits 1 and 2**



## San Jacinto River Waste Pits

 1966 Original Perimeter  
of Impoundments



Sources:  
**Aerial Photo:** Digital Globe, 2007.  
**Impoundment Boundaries:** Created by  
EPA Region 6 using 1966 aerial photo from USGS.

EPA makes no claims as to the  
accuracy of the data or its suitability  
for any particular use.

Map created: March 17, 2010



EPA Region 6  
GIS Support Team  
Dallas, Texas  
20100317M1.02



**Attachment 3**

**Site photos of waste entering San Jacinto River dated 03/01/2010**



**Attachment 4**

**ATSDR Fact Sheets on Dioxins/Furans**

This fact sheet answers the most frequently asked health questions (FAQs) about dibenzo-p-dioxins. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

**HIGHLIGHTS:** Exposure to chlorinated dibenzo-p-dioxins (CDDs) (75 chemicals) occurs mainly from eating food that contains the chemicals. One chemical in this group, 2,3,7,8-tetrachlorodibenzo-p-dioxin or 2,3,7,8-TCDD, has been shown to be very toxic in animal studies. It causes effects on the skin and may cause cancer in people. This chemical has been found in at least 91 of the 1,467 National Priorities List sites identified by the Environmental Protection Agency (EPA).

### What are CDDs?

CDDs are a family of 75 chemically related compounds commonly known as chlorinated dioxins. One of these compounds is called 2,3,7,8-TCDD. It is one of the most toxic of the CDDs and is the one most studied.

In the pure form, CDDs are crystals or colorless solids. CDDs enter the environment as mixtures containing a number of individual components. 2,3,7,8-TCDD is odorless and the odors of the other CDDs are not known.

CDDs are not intentionally manufactured by industry except for research purposes. They (mainly 2,3,7,8-TCDD) may be formed during the chlorine bleaching process at pulp and paper mills. CDDs are also formed during chlorination by waste and drinking water treatment plants. They can occur as contaminants in the manufacture of certain organic chemicals. CDDs are released into the air in emissions from municipal solid waste and industrial incinerators.

### What happens to CDDs when they enter the environment?

- ☐ When released into the air, some CDDs may be transported long distances, even around the globe.
- ☐ When released in waste waters, some CDDs are broken down by sunlight, some evaporate to air, but most attach to soil and settle to the bottom sediment in water.
- ☐ CDD concentrations may build up in the food chain, resulting in measurable levels in animals.

### How might I be exposed to CDDs?

- ☐ Eating food, primarily meat, dairy products, and fish, makes up more than 90% of the intake of CDDs for the general population.
- ☐ Breathing low levels in air and drinking low levels in water.
- ☐ Skin contact with certain pesticides and herbicides.
- ☐ Living near an uncontrolled hazardous waste site containing CDDs or incinerators releasing CDDs.
- ☐ Working in industries involved in producing certain pesticides containing CDDs as impurities, working at paper and pulp mills, or operating incinerators.

### How can CDDs affect my health?

The most noted health effect in people exposed to large amounts of 2,3,7,8-TCDD is chloracne. Chloracne is a severe skin disease with acne-like lesions that occur mainly on the face and upper body. Other skin effects noted in people exposed to high doses of 2,3,7,8-TCDD include skin rashes, discoloration, and excessive body hair. Changes in blood and urine that may indicate liver damage also are seen in people. Exposure to high concentrations of CDDs may induce longterm alterations in glucose metabolism and subtle changes in hormonal levels.

In certain animal species, 2,3,7,8-TCDD is especially harmful and can cause death after a single exposure. Exposure to lower levels can cause a variety of effects in



ToxFAQs™ Internet address is <http://www.atsdr.cdc.gov/toxfaq.html>

animals, such as weight loss, liver damage, and disruption of the endocrine system. In many species of animals, 2,3,7,8-TCDD weakens the immune system and causes a decrease in the system's ability to fight bacteria and viruses. In other animal studies, exposure to 2,3,7,8-TCDD has caused reproductive damage and birth defects. Some animal species exposed to CDDs during pregnancy had miscarriages and the offspring of animals exposed to 2,3,7,8-TCDD during pregnancy often had severe birth defects including skeletal deformities, kidney defects, and weakened immune responses.

### How likely are CDDs to cause cancer?

Several studies suggest that exposure to 2,3,7,8-TCDD increases the risk of several types of cancer in people. Animal studies have also shown an increased risk of cancer from exposure to 2,3,7,8-TCDD.

The World Health Organization (WHO) has determined that 2,3,7,8-TCDD is a human carcinogen.

The Department of Health and Human Services (DHHS) has determined that 2,3,7,8-TCDD may reasonably be anticipated to cause cancer.

### How can CDDs affect children?

Very few studies have looked at the effects of CDDs on children. Chloracne has been seen in children exposed to high levels of CDDs. We don't know if CDDs affect the ability of people to have children or if it causes birth defects, but given the effects observed in animal studies, this cannot be ruled out.

### How can families reduce the risk of exposure to CDDs?

- ☐ Children should avoid playing in soils near uncontrolled hazardous waste sites.
- ☐ Discourage children from eating dirt or putting toys or other objects in their mouths.

☐ Everyone should wash hands frequently if playing or working near uncontrolled hazardous waste sites.

☐ For new mothers and young children, restrict eating foods from the proximity of uncontrolled sites with known CDDs.

☐ Children and adults should eat a balanced diet preferably containing low to moderate amounts of animal fats including meat and dairy products, and fish that contain lower amounts of CDDs and eat larger amounts of fruits, vegetables, and grains.

### Is there a medical test to determine whether I've been exposed to CDDs?

Tests are available to measure CDD levels in body fat, blood, and breast milk, but these tests are not routinely available. Most people have low levels of CDDs in their body fat and blood, and levels considerably above these levels indicate past exposure to above-normal levels of 2,3,7,8-TCDD. Although CDDs stay in body fat for a long time, tests cannot be used to determine when exposure occurred.

### Has the federal government made recommendations to protect human health?

The EPA has set a limit of 0.00003 micrograms of 2,3,7,8-TCDD per liter of drinking water (0.00003 µg/L). Discharges, spills, or accidental releases of 1 pound or more of 2,3,7,8-TCDD must be reported to EPA. The Food and Drug Administration (FDA) recommends against eating fish and shellfish with levels of 2,3,7,8-TCDD greater than 50 parts per trillion (50 ppt).

### References

Agency for Toxic Substances and Disease Registry (ATSDR). 1998. Toxicological Profile for Chlorinated Dibenzo-p-Dioxins. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

**Where can I get more information?** For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-62, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is <http://www.atsdr.cdc.gov/toxfaq.html>. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.



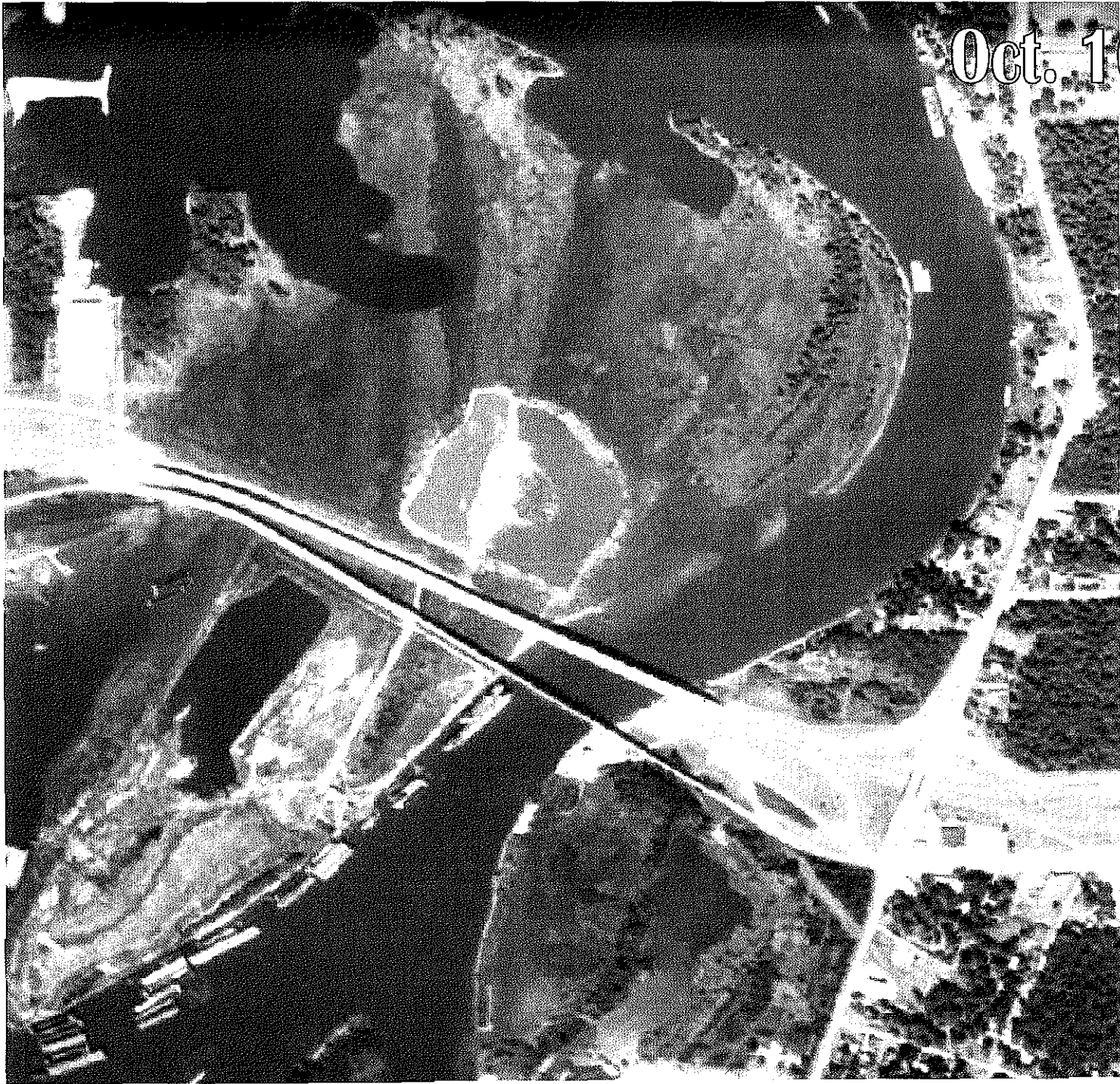
**Attachment 5**

**Enforcement Addendum (Enforcement Confidential/FOIA Exempt)**

**Attachment 6**

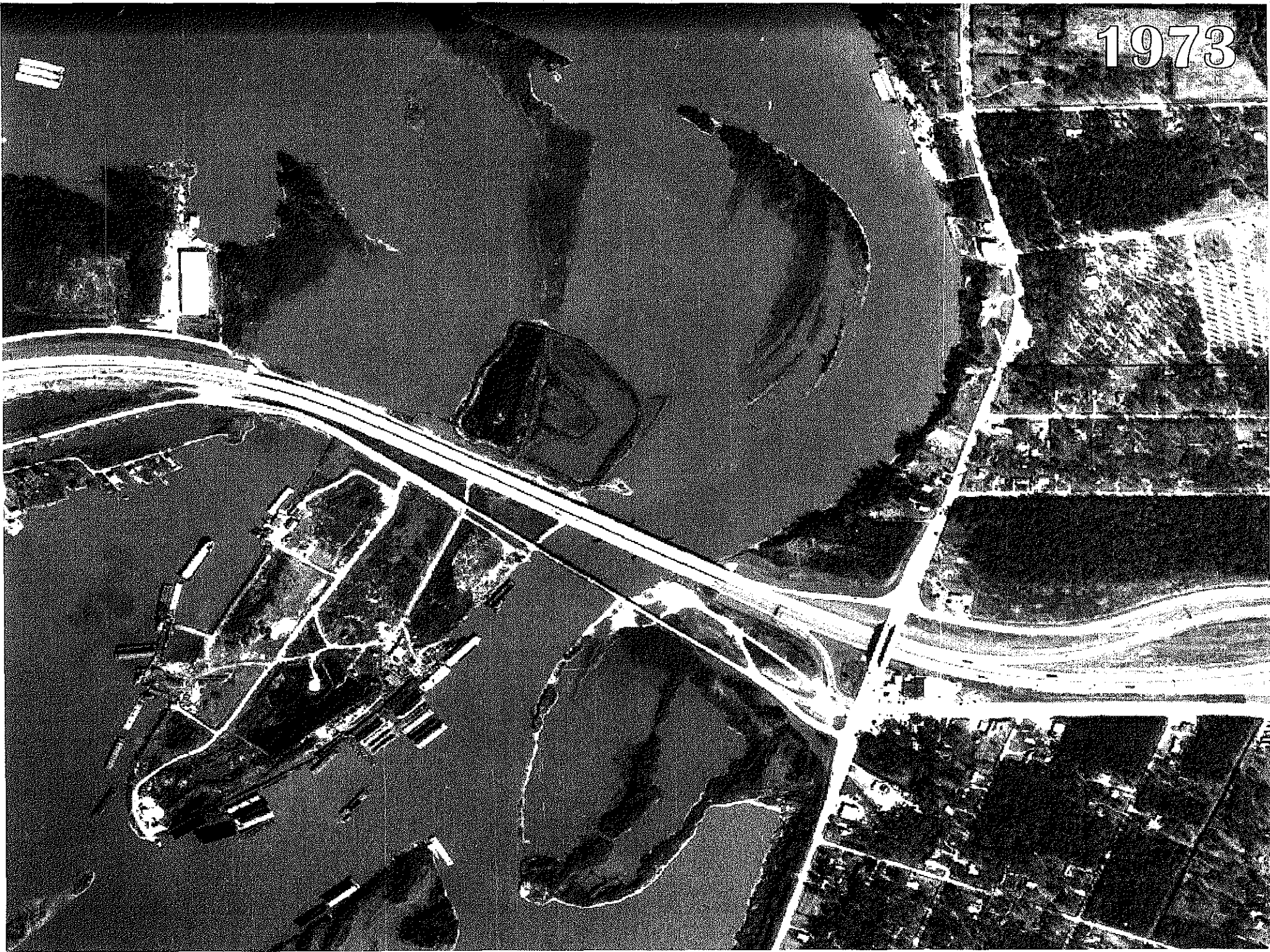
**Historical Aerial photos of site**

Oct. 16, 1966





1973

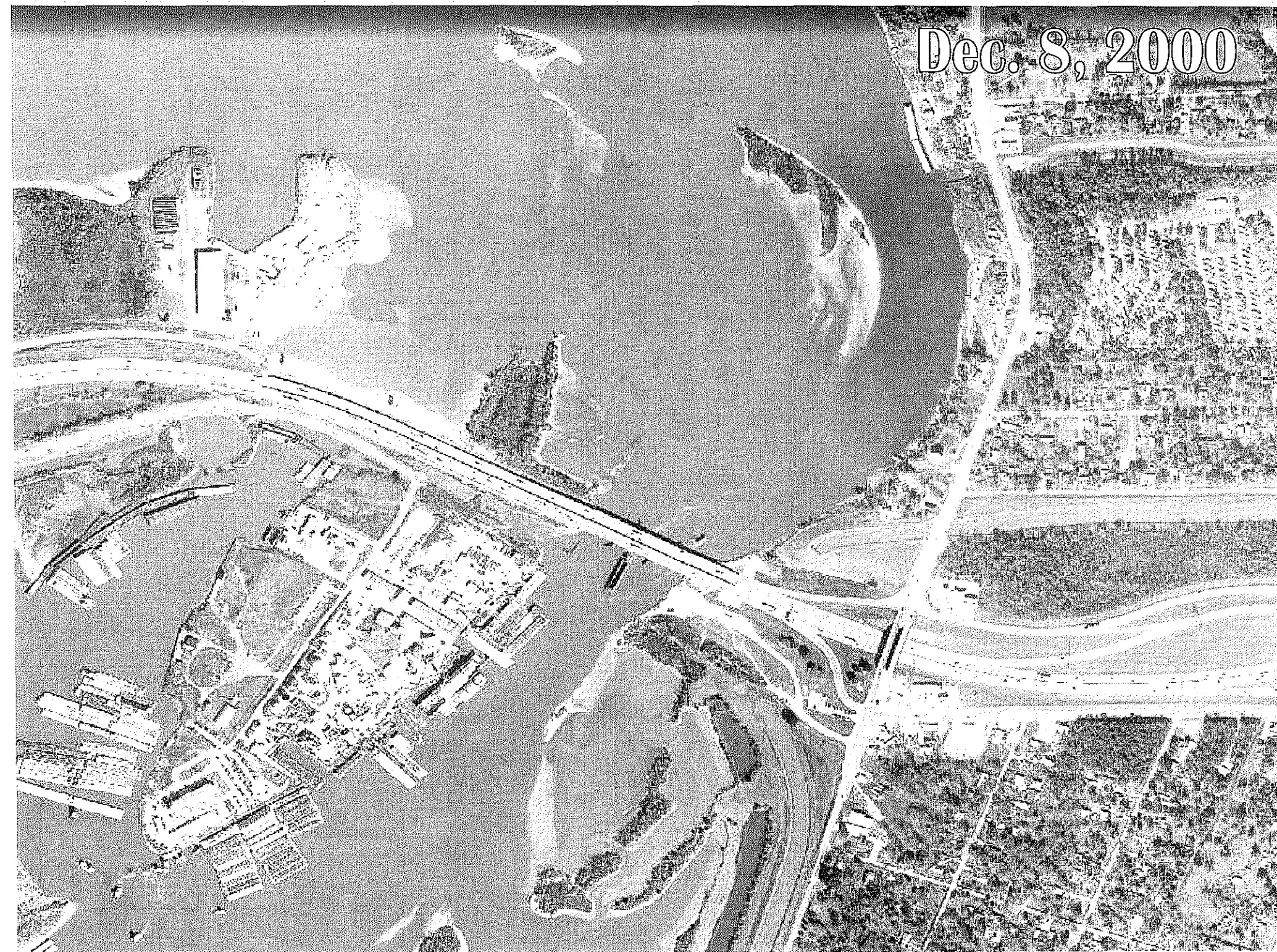


1989



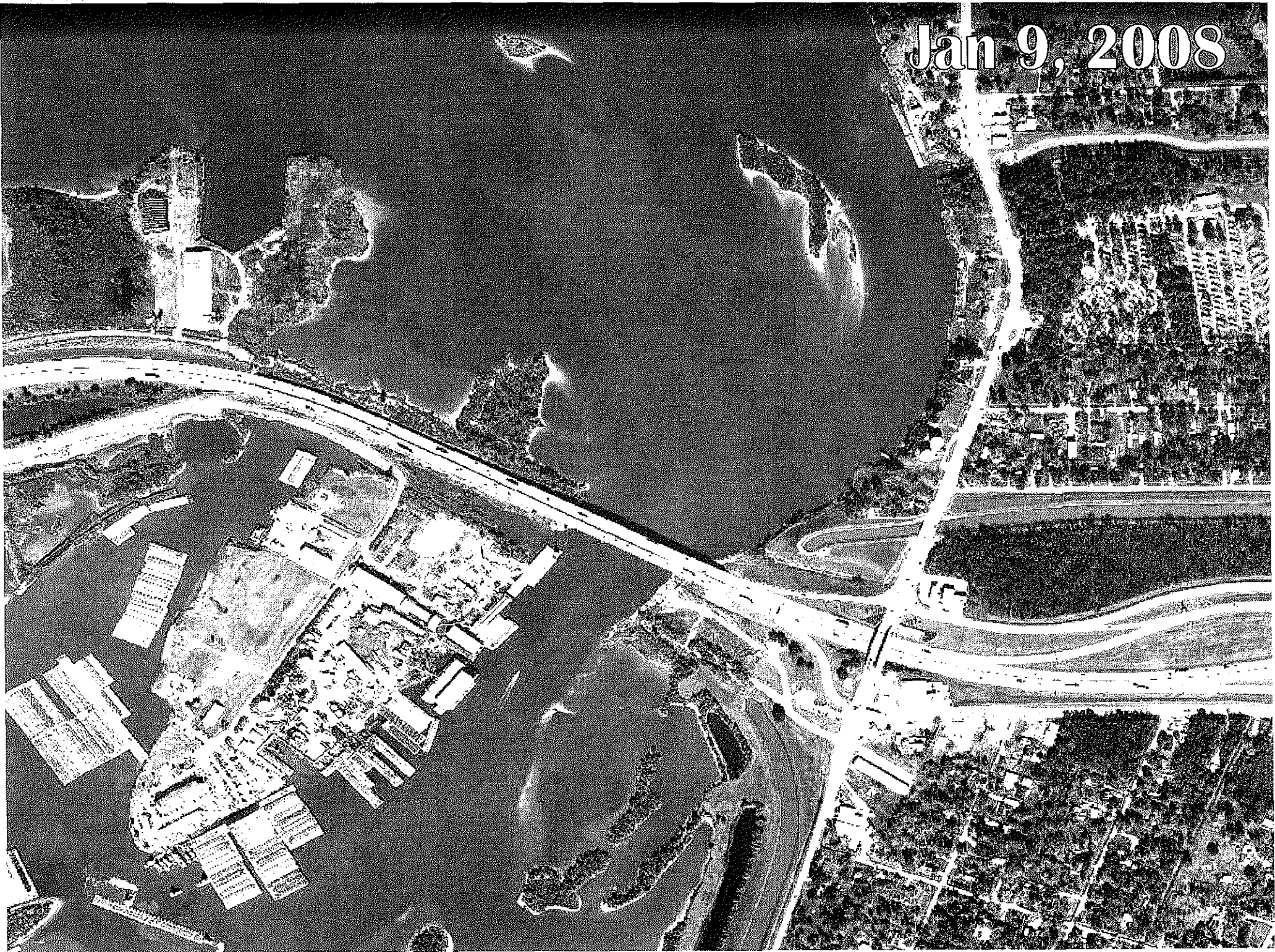


Dec. 8, 2000





Jan 9, 2008





**Attachment 7**

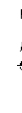
**1966 Datum Map with original impoundments line superimposed**

## San Jacinto River Waste Pits

### Surface Sediment Samples\*

- ⊕ URS (2010)
- TCEQ and USEPA (2006)
- U of H and Parsons (2006)
- ▭ Original Perimeter of Impoundments

\*2,3,7,8-TCDD Equivalents (TEQs) in Surface Sediments  
(pg/g ds; ND=1/2DL, WHO 05)



### Sources:

**Aerial Photo:** Digital Globe, 2007.  
**Sample Data:** Database compiled by Integral Consulting, January 2010. Sample sources include URS, TCEQ, US EPA, University of Houston, and Parsons.  
**Impoundment Boundaries:** Created by EPA Region 6 using 1966 aerial photo from USGS.

EPA makes no claims as to the accuracy of the data or its suitability for any particular use.

Map created: March 17, 2010



EPA Region 6  
GIS Support Team  
Dallas, Texas  
20100317SILJH



REVISED DRAFT  
TIME CRITICAL REMOVAL ACTION ALTERNATIVES ANALYSIS  
SAN JACINTO RIVER WASTE PITS SUPERFUND SITE

**Prepared for**

U.S. Environmental Protection Agency, Region 6

**On behalf of**

McGinnes Industrial Maintenance Corporation

And

International Paper Company

**Prepared by**

Anchor QEA, LLC

614 Magnolia Avenue

Ocean Springs, Mississippi 39564

**June 2010**

# REVISED DRAFT TIME CRITICAL REMOVAL ACTION ALTERNATIVES ANALYSIS SAN JACINTO RIVER WASTE PITS SUPERFUND SITE

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**June 2010**



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## LIST OF ACRONYMS AND ABBREVIATIONS

|                 |  |
|-----------------|--|
| ACBM            | articulated concrete block mat   |
| ADCP            | acoustic Doppler current profiler  |
| AOC             | Administrative Order on Consent  |
| BCD             | base catalyzed decomposition   |
| BMPs            | best management practices  |
| CERCLA          | Comprehensive Environmental Response, Compensation, and Liability Act (a.k.a, Superfund) |
| cfs             | cubic feet per second  |
| D <sub>50</sub> | median diameter  |
| I-10            | Interstate Highway 10  |
| IPC             | International Paper Company  |
| MIMC            | McGinnes Industrial Maintenance Corporation  |
| MSL             | mean sea level   |
| NAVD 88         | North American Vertical Datum of 1988  |
| ng/kg           | nanograms per kilogram   |
| NPL             | National Priorities List   |
| NTCRA           | non-Time Critical Removal Action   |
| OM&M            | operations, monitoring and maintenance   |
| OTA             | USEPA Office of Technology Assessment  |
| RI/FS           | Remedial Investigation/Feasibility Study   |
| Site            | San Jacinto River Waste Pits Superfund Site  |
| S/S             | solidification/stabilization   |
| TCDD            | 2,3,7,8-tetrachlorodibenzo-p-dioxin  |
| TCEQ            | Texas Commission on Environmental Quality  |
| TCRA            | Time Critical Removal Action   |
| TOC             | total organic carbon   |
| UAO             | Unilateral Administrative Order  |
| USACE           | United States Army Corps of Engineers  |
| USEPA           | United States Environmental Protection Agency  |

## **1 INTRODUCTION**

### **1.1 Project Background**

The San Jacinto River Waste Pits Superfund Site (Site) is located on the San Jacinto River, east of Houston, in Harris County, Texas (Figure 1). On March 19, 2008, the United States Environmental Protection Agency (USEPA) listed the Site on the National Priorities List (NPL) and USEPA issued a Unilateral Administrative Order (UAO), Docket No. 06-03-10, to International Paper Company (IPC) and McGinnes Industrial Maintenance Corporation (MIMC) (collectively, the Respondents) on November 20, 2009, (USEPA 2009). The 2009 UAO directs IPC and MIMC to conduct a Remedial Investigation and Feasibility Study (RI/FS) for the Site.

In addition, MIMC and IPC entered into an Administrative Order on Consent (AOC), Docket No. 06-03-10, to conduct a Time Critical Removal Action (TCRA) in April 2010 (USEPA 2010). The TCRA is to stabilize the Site, temporarily abating any release of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans into the waterway, until the Site is fully characterized and a remedy is selected (USEPA 2010).

After the TCRA has been completed, USEPA will make a determination about the need for future actions at the Site. This report was prepared pursuant to the requirements of the AOC, which calls for a comparative evaluation of various alternatives for the TCRA. A brief description and history of the Site are provided in Section 1.2, a summary of existing physical conditions relevant to the TCRA is provided in Section 1.3, and a summary of extent and major elements of the TCRA is provided in Section 1.4, to provide a basis for the analyses presented in subsequent sections.

### **1.2 Site Description and History**

The Site consists of a set of impoundments approximately 15.7 acres in size, built in the mid-1960s for disposal of paper mill wastes. The Site also includes the surrounding areas containing sediments and soils potentially contaminated with the waste materials that had been disposed of in the impoundments. The set of impoundments is located on a 20-acre parcel on the western bank of the San Jacinto River, in Harris County, Texas, immediately north of the Interstate Highway 10 (I-10) Bridge over the San Jacinto River (Figure 1).

In 1965, the impoundments were constructed by forming berms within the estuarine marsh, just north of what was then Texas State Highway 73 (now I-10), to the west of the main river channel. The two primary impoundments at the Site were divided by a central berm running lengthwise (north to south) through the middle, and were connected with a drain line to allow flow of excess water (including rain water) from the impoundment located to the west of the central berm, into the impoundment located to the east of the central berm (Figure 1).

In 1965 and 1966, pulp and paper mill wastes (both solid and liquid) were reportedly transported by barge and unloaded at the Site into the impoundments. The wastes deposited in the impoundments have recently been found to be contaminated with polychlorinated dibenzo-p-dioxins, polychlorinated furans (dioxins and furans), and some metals (TCEQ and USEPA 2006). Physical changes at the Site in the 1970s, 1980s, and 1990s, including regional subsidence of land in the area, due to large-scale groundwater extraction and sand mining within the river and marsh to the west of the impoundments, have resulted in partial submergence of the berms and exposure of the contents of the impoundments to surface waters. Based on permit reviews, aerial photograph interpretation, recent bathymetric survey results, and an evaluation of the distribution of dioxin in surface sediments surrounding the Site, it appears that sand mining-related dredging occurred in the vicinity of the perimeter berm at the northwest corner of the impoundments in 1997 or 1998. These dredging activities appear to have impacted the berms on the northwestern portion of the impoundment.

### **1.3 Existing Conditions**

The impoundments are currently occupied by late-successional stage estuarine riparian vegetation to the west of the central berm, and are consistently submerged even at low tide to the east of the central berm. Estuarine riparian vegetation also lines the upland area that runs parallel to I-10. A sandy intertidal zone is present along the shoreline throughout much of the Site.

### **1.3.1 Bathymetry**

The bathymetry and geometry of the San Jacinto River in the vicinity of the Site may be separated into three regions: 1) vicinity of waste impoundments (i.e., within about 0.5 mile of the waste impoundments); 2) upstream of the waste impoundments (i.e., extending about 4 miles upstream of the waste impoundments); and 3) downstream of I-10 Bridge to the confluence with the Houston Ship Channel. In the vicinity of the waste impoundments, a large portion of the area is relatively shallow, with water depths of about 2 to 6 feet. The shallow areas contain some intertidal zones that may have an exposed sediment bed during low tide conditions. The area located to the west and northwest of the waste impoundments has been affected by past sand mining operations, with the dredged areas having typical water depths of 16 to 18 feet. The main channel of the river (upstream of the I-10 Bridge) is located to the north and east of the waste impoundments, with typical depths of 20 to 30 feet in the channel.

In the region upstream of the waste impoundments, the San Jacinto River winds northward through an unconfined channel (10 to 20 feet deep) that is surrounded by a relatively wide area of shallower water (typically 3 to 4 feet, or less). The river becomes confined to a single channel about 4 miles upstream of the waste impoundments, with this single channel continuing upstream to the Lake Houston dam.

Downstream of the I-10 Bridge, the main channel of the river extends for about 2 miles until the confluence with the Houston Ship Channel. The main channel is navigable with depths ranging from 15 to 30 feet. Shallower areas exist along the eastern shore of the main channel, with depths of 6 feet or less. The old river channel branches off from the main channel about 0.5 miles downstream of the I-10 Bridge. Water depths in the old river channel are typically 6 feet or less.

### **1.3.2 Hydrography**

Flow rates in the San Jacinto River in the vicinity of the Site are partially controlled by the Lake Houston dam, which is located about 28 miles upstream of the waste impoundments. The average flow in the river is 2,200 cubic feet per second (cfs). Floods in the river primarily occur during tropical storms (e.g., hurricanes) or intense thunderstorms. Extreme



flood events have flow rates of 200,000 cfs or greater. The October 1994 flood had a peak discharge of 360,000 cfs, which has a return period of greater than 100 years. River stage height during the October 1994 flood had a maximum value of 27 feet above mean sea level (MSL).

The river in the vicinity of the waste impoundments is affected by diurnal tides, with a typical tidal range of 1 to 2 feet. Tidal range varies over a 14-day cycle, with neap and spring tide conditions corresponding to minimum and maximum tidal ranges, respectively.

Tropical storms and wind storms from the north can have significant effects on water levels at the Site. Tropical storms can cause storm surges with water levels that are significantly higher than typical tidal elevations. Storms with strong winds from the north can cause water to be transported out of the Galveston Bay system, which can result in water levels that are much lower than low tide elevations.

Salinity in the vicinity of the waste impoundments generally ranges between 10 and 20 parts per thousand during low to moderate flow conditions in the river. During floods, salinity values will approach freshwater conditions.

## **1.4 Streamlined Risk Evaluation**

USEPA directed MIMC and IPC to collect additional soil and sediment data along the perimeter of the Site in a request received by email on Friday, March 26, 2010, to determine the potential area requiring stabilization as part of the TCRA. The sampling was conducted April 13 to April 15, 2010, and included surface sediment and soil sampling and analysis of dioxin and furan congeners and total organic carbon (TOC) at 25 locations in and near the impoundments located along five transects, with five stations located along each transect.

The results of the TCRA sediment and soil sampling are provided in Figure 2. This figure shows that surface sediments and soils within the footprint of the former waste impoundments exceed relevant criteria (330 nanograms per kilogram [ng/kg] 2,3,7,8-tetrachlorodibenzo-p-dioxin [TCDD] organic carbon normalized, or 4.5 ng/kg TCDD non-

organic carbon normalized) established by USEPA as requiring immediate action within the original bermed perimeter.

As described in the Action Memorandum (USEPA 2010, Appendix A), the TCRA involves the following major elements:

- Public access restrictions must be put in place.
- Immediate design and construction of a physical protective barrier surrounding Waste Ponds 1 and 2 that addresses the release, or threat of release of dioxins and furans into the San Jacinto River.
  - Any concentrations greater than 330 ng/kg of TCDD organic carbon normalized (or 4.5 ng/kg TCCD non-organic carbon normalized) in the sediment will be considered part of the source area of contamination within the original 1966 berm placement, and must be addressed with the protective barrier.
- Design and construction of the barrier must be structurally sufficient to withstand forces sustained by the river, including any future erosion, and be structurally sound for a number of years until a final remedy is designed and implemented. This includes accounting for seasonal severe weather events.

## **1.5 Purpose of Document**

This document presents an engineering evaluation and cost analysis to compare several conceptual design alternatives for the TCRA. The following major topics are discussed:

- Evaluation criteria used
- Technology screening for removal action strategies
- Design criteria used to develop removal action alternatives
- Description of the removal action alternatives considered
- Comparative evaluation of the removal action alternatives
- Recommended removal action alternative
- References and appendices to provide additional details as appropriate

This document is an updated version of the May 2010 draft alternatives analysis and has been revised at the request of USEPA to include additional technology screening discussion regarding potential treatment options.

---

## 2 EVALUATION CRITERIA

Five removal action alternatives were selected in consultation with USEPA and evaluated following Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidance against the following three criteria:

- Effectiveness
- Implementability
- Cost

The evaluation of each of these criteria is described below.

### 2.1 Effectiveness Evaluation

Based on the Action Memorandum (USEPA 2010, Appendix A), the following removal action objectives for the TCRA were identified:

- Control erosion of waste materials
  - Source materials are considered sediments located within the original 1966 berm footprint and with concentrations greater than or equal to 330 ng/kg TCDD organic carbon normalized or 4.5 ng/kg TCDD non-organic carbon normalized. (USEPA 2010, Appendix A, IV.A.1; Page 9; 2nd paragraph)
  - Erosion can occur from upland runoff, river and tidal currents, waves, and propeller wash. (USEPA 2010, Appendix A, III.A.4)
  - Technologies used to control erosion “must be structurally sufficient to withstand forces sustained by the river including any future erosion and be structurally sound for a number of years until a final remedy is designed and implemented.” (USEPA 2010, Appendix A, IV.A.1; Page 9; 3rd paragraph)
- Prevent direct human contact with the waste materials. (USEPA 2010, Appendix A, IV.A.1; Page 9; 1st paragraph). Humans come into contact with the material accessing the Site by land and water.
- Prevent benthic contact with the waste materials. (USEPA 2010, Appendix A, III.B)



- Ensure that the “actions are consistent with any long term remediation strategies that may be developed for the Site.” (USEPA 2010, Appendix A, V.A.2). The TCRA should not constrain the future non-Time Critical Removal Action (NTCRA) remedy.

Based on these objectives, the effectiveness evaluation will focus on the following:

- The effectiveness of the remedy to isolate waste or sediments with concentrations of 2,3,7,8 TCDD above the action levels described above from exposure or transport off-site to addresses the release, or threat of release, of dioxins and furans into the San Jacinto River from the Site
- The potential ability of the remedy to withstand and remain in place and effective during and after extreme weather events (see Appendices A and B for more detail on design storm event and hydrodynamic model description)
- The potential effectiveness of the technology to prevent benthic contact with the waste materials
- The potential effectiveness of the technology to prevent direct human contact with the waste materials
- The potential impacts to human health and the environment during construction
- The potential effectiveness and consistency of the technologies with any long-term remediation strategies for the Site

## **2.2 Implementability Evaluation**

The implementability criterion focuses on:

- Availability of the materials and equipment to implement the technologies
- Availability of skilled labor to implement the technologies
- Expected construction challenges or constraints for a specific technology
- Potential impacts of the remedy on navigation and/or flood control

In addition to evaluating technical issues associated with implementability, the evaluation also includes the expected construction duration for each alternative. There is a preference for actions that require a shorter duration to implement.

## **2.3 Cost Evaluation**

Costs for the different alternatives will be developed to an accuracy of +/-30 percent for comparative purposes. The focus of the cost evaluation is to make comparative estimates for alternatives with relative accuracy. As described in Appendix C, the costs include capital and operations, maintenance, and monitoring (OM&M) costs. As recommended by the USEPA, OM&M costs are assumed for a period of 7 years before future actions are implemented at the Site.

---

### **3 INITIAL TECHNOLOGY SCREENING**

There are three general categories of technologies that are applicable to removal actions at sediments sites. This section provides a technical screening and discusses potential project-specific considerations as they apply to these technologies. The three categories of technologies are:

- Removal
- Containment
- Treatment

These strategies were initially screened from the wide range of technologies available by considering their successful implementation under similar conditions at other NPL sites.

#### **3.1 Removal**

Removal entails the excavation of soils or sediments that exceed specified criteria. Once excavated, the material would be managed in an engineered containment facility, either on-site or off-site. Removal would also be required for any ex situ treatment options that may be implemented as discussed in Section 3.3. For the Site, the scope of removal could entail excavation both above and below the existing water surface.

##### **3.1.1 Upland Removal**

Excavation above the water surface (upland removal) could be accomplished with conventional earthwork equipment (e.g., backhoes, excavators, or dozers), and would be applicable to the Western Cell area of the Site. Upland removal would require a suitable staging area to manage stockpiles of excavated material. Stockpiles would need to be protected from erosion and surface water runoff, and would need to be contained to prevent the uncontrolled release of excavated material.

Track-mounted excavators would remove target material until the design grade is achieved. Side slopes would need to be flat enough to provide safe working conditions. Water would need to be managed during excavation to prevent uncontrolled release of contaminated

water from the Site. This could be achieved using sumps and pumps to transfer water from the excavation to a containment tank.

Once excavated, material would need to be managed on-site or prepared for off-site management. To prepare for off-site management, some dewatering might be necessary. This could be achieved through adding a drying amendment, or by allowing gravity dewatering (provided sufficient space exists for the excavated volume).

For material being managed off-site, a loading area would be required. Trucks entering the Site would be loaded with material using a trackhoe or front-end loader. Trucks would need to be lined and covered to prevent spillage of material during transportation, and the material would need to be suitably dewatered to comply with shipping regulations and for acceptance at the receiving facility.

It is expected that significant Site access constraints would cause upland excavation and associated materials handling to be an inefficient process.

### **3.1.2 In Water Removal**

Within the northwest area of the Site and in the Eastern Cell, removal would need to be performed using a water-based operation (i.e., dredging). Because of the shallow-water nature of most of the Site, the appropriate dredging technology would need to be carefully considered. The material barge required by a conventional clamshell derrick (mechanical dredging) would likely require more water depth than is present on the Site. Thus, dredging would need to be performed with a hydraulic dredge or marsh-buggy excavator.

A marsh-buggy excavator would have limited application at the Site, due to the deeper water present in the northwestern area. At the depths of water present in this area, the marsh buggy chassis would float, which would prevent excavation. Thus, water-based removals would most likely be performed using a hydraulic dredge in this portion of the Site.

A small (8 to 10-inch diameter) hydraulic dredge would be compatible with the size of the Site, expected dredge volumes, size of the upland material management area, and depth of



water available. The dredge may use a shrouded cutterhead, or may employ suction only depending on the characteristics of the dredge material. Appropriate best management practices would be employed to protect water quality and the environment during dredging.

Once dredging has been completed, the dredged materials need to be managed. For on-site management, appropriate controls would be required to contain the material. The Site does not have enough surface area to create a settling basin to manage the dredge material; therefore, to manage material from a hydraulic dredging operation, geotubes would be used to contain the dredge material and to facilitate controlled dewatering of the sediment.

For off-site disposal, an appropriate and approved receiving facility must be identified. In this case, excavated material would need to be properly dewatered, loaded onto trucks and transferred to the off-site location for disposal in a fashion similar to that described for upland removal. As with upland excavation, it is expected that these operations would be significantly hindered by Site access constraints and would consequently be inefficient.

Hydraulic dredging with on-site management using geotubes is a common strategy that has been used on other cleanup projects. The technology is well understood, and is readily available. Thus, it has been retained for further evaluation as a component of the alternatives considered in this report.

### **3.2 Containment**

Containment entails physically separating the contaminants of concern from environmental receptors. For the TCRA, isolation would be necessary for all sediments that are actively eroding, or could potentially erode within the historic footprint of the impoundments.

There are several strategies for containment. Commonly, containment for sediments entails placement of a cover of clean sediment and/or aggregate on top of target materials (Palermo et. al. 1998; USEPA 2005), or a man-made cover of geotextile and/or cast-in-place concrete. Containment can also be achieved by constructing a physical barrier (e.g., sheet pile wall or geotube berm) around the area of interest.

As noted under the discussion for removal, the Site has limited water depth. Based on conversations with a local marine contractor (Orion 2010), measures to construct granular or sheet pile containment from the water (e.g., through the use of a flexi-float barge setup) could pose a risk for barge grounding and/or catastrophic equipment loss. As a result of these discussions, the construction of containment for the conceptual alternatives has been assumed to be performed from the land where the water is shallow.

### **3.2.1 Granular Containment Cover**

Granular containment cover entails the placement of a layer of aggregate with a gradation that has been sized to withstand a design-level erosion event. This placement could be done from the land, or from the water. Depending on the required gradation of the granular material, it could be sourced from a local quarry, from a remote quarry, or from a local concrete recycling operation. Granular containment covers are commonly used for sediment cleanup projects (USEPA 2005).

### **3.2.2 Articulated Concrete Block Mat Containment Cover**

The articulated concrete block mat (ACBM) containment cover entails placement of a multi-layer, cable-reinforced geotextile fabric over the cover area, and pumping the interstitial pockets of the fabric with a lean concrete grout. Once the grout hardens an interconnected pillow-like structure of concrete remains in place to act as a protective cover. The hardened structure prevents penetration of the surface by human or benthic organisms, and prevents further erosion of the covered sediment.

Past project experience has identified potential scour and undermining of ACBM materials when the installed edge is submerged within a flowing water body. To address this potential concern, the ACBM cover includes a perimeter scour apron constructed of rock material for all submerged edges of the mattress.

The ACBM containment cover strategy has been used on other remedial projects, although it is not as commonly used as granular covers have been.

### **3.2.3 Sheet Pile Containment Wall**

Sheet pile containment can be used to physically separate soils and sediments from the surrounding environment with a vertical wall. The sheet pile would be installed using conventional pile-driving equipment staged from a land-based operation or from a barge, depending on Site access constraints. Sheet pile walls can be designed to have very low permeability if the specific goal of containment is to prevent migration of dissolved phase contamination.

Two materials are commonly used for sheet pile containment: steel and composite (i.e., vinyl). Each material has advantages and disadvantages compared to the other.

Steel sheet piles are readily available in a variety of cross sections and strengths. Steel is relatively expensive and heavy to handle on-site, requiring larger installation equipment. However, steel is very strong and can resist higher lateral loads before significant deflections occur. Also, steel can withstand high forces and bending moments produced during driving and vibrating through fill and adverse soil conditions. Steel can also be field-welded to make repairs or lengthen sheets. Finally, steel may have a salvage value that can reduce the overall cost of its use, depending on the condition of the sheets.

Composite sheet piles are also available in a variety of cross sections and strengths. Compared to steel, composite sheet piles are less expensive and lighter to handle. Composite sheets are typically very flexible compared to steel and can be subject to significant deflections under lateral loads. They are also less resistant to impact loads compared to steel sheets. Composite sheets must be installed with a specialized mandrel that allows the sheet to be driven or vibrated in to its tip elevation without damaging the sheet. Once the composite sheet is driven to depth, the mandrel is detached from the sheet and pulled back up from below the ground surface for reuse in the next sheet installation. Composite sheets are expected to have zero salvage value when used in a remedial environment. Based on feedback from USEPA during alternatives development, and after conversations with a composite material supplier, composites may still be appropriate for use in the TCRA and could present the opportunity for reduced costs compared to the use of steel. Thus, composite sheets were selected for the conceptual alternatives that involve a sheet pile containment structure. The potential limitations of composite materials would be further

evaluated during detailed design. The costs to switch to steel sheet piles from composite are presented in the cost evaluation section.

Sheet piles are sensitive to unbalanced, or cantilevered, loading. In typical shoreline applications, lateral support against wave and water forces is provided by the soil behind the sheet pile. However, in the application considered for this TCRA, the sheet pile would be surrounded by water on both sides, and a provision would need to be made to balance the hydraulic forces on both sides of the sheet pile.

There are several strategies to provide additional lateral support against hydraulic forces. First, a rock or gabion buttress could be constructed on both sides of the wall to reduce the cantilever height. In addition, weep holes can be installed through the sheets to allow water to pass through the sheets and prevent unbalanced water loads from developing on one side of the sheet.

The use of gabion walls for a sheet pile buttress was not considered in detail for this evaluation. Gabion walls are considered potentially difficult to install under water compared to a rock revetment. However, if the TCRA contractor were to determine that gabion walls would be a preferred strategy for constructing a sheet pile buttress; their use would be further considered during detailed design.

In addition to considering lateral support for cantilevered sheet piles, scour potential at the base of the sheet pile must be considered. The hydrodynamic modeling described in Section 4.3 can be used to help identify areas where the presence of a vertical wall could increase the potential for localized scour. To prevent undermining, a scour apron would need to be constructed using aggregate placed at the base of the wall.

### **3.2.4 Geotube Containment Berm**

In addition to their use to contain dredged sediment, geotubes can be used to construct the core of a barrier berm around a site. In this application, geotubes would be filled with a granular material that would provide some structural integrity to the core of the berm in the event that the geotube deteriorated. The outside edges and top of the berm would be



constructed of traditional aggregate material around the geotube to provide protection to the berm core.

While the use of a geotube to create the core of an isolation berm has not been expressly included in the alternatives development, this option could be suggested as a value engineering opportunity by the TCRA contractor.

As with removal, isolation is a common strategy that has been used on many cleanup projects. The technology is readily available and multiple strategies for effective isolation have been demonstrated at other sites. Thus, it has been retained for further evaluation as a component of the alternatives considered in this report.

### **3.3 Treatment**

A variety of information sources, including the EPA CLU-IN database and published reports (Office of Technology Assessment [OTA] 1991, USEPA 2005b, USDOE 2003, USEPA 2009b), were reviewed to identify potential treatment technologies for the TCRA. Applicable treatments are those that are demonstrated and commercially available to reduce the toxicity and mobility of dioxin in the sediment and sludge. Based on this review, the following technologies were identified as potentially applicable for treating dioxins in sludge and sediment:

- Incineration
- Solidification/stabilization (S/S)
- Chemical dehalogenation

#### **3.3.1 Incineration**

Incineration is a demonstrated ex situ technology for treating organic contaminants. Impacted sediment would be excavated using upland equipment and/or dredged hydraulically and dewatered as described in Section 3.1. The dewatered sediment would be transported by truck to a permitted commercial incinerator with the appropriate destruction and removal efficiency for handling dioxin-bearing materials.

The Clean Harbors incinerator in Deer Park, Texas, may have the appropriate technology and authorization to treat material from the Site. The ability of the Clean Harbors facility to handle Site materials is dependent on the results of a waste profile, which would be required to further evaluate this treatment option. The travel distance from the Site to the incinerator in Deer Park is approximately 20 miles. Incineration will be much more expensive on a per unit basis than the other options discussed in this section. The cost to incinerate sediment from the Site is expected to exceed \$400 per ton (not including require removal, dewatering, and transportation of materials). In order to perform incineration, sediment removal, dewatering, loading and transportation to the incinerator would add approximately \$75 to \$100 per ton. Incineration would increase the cost of TCRA significantly, without enhancing the stabilization of the Site compared to the other options.

### **3.3.2     *Solidification/Stabilization***

S/S is a demonstrated in situ and ex situ technology for increasing the bearing strength and reducing the mobility and permeability of soil, sediment, and sludge. For many constituents, S/S has also been shown to chemically bind the contaminants to the solidified matrix. Due to the nature of dioxins to adsorb strongly to solid particles, leaching of dioxin into the aqueous phase is expected to be insignificant, and the reduction of leaching would thus not be an objective of treatment for the TCRA. Rather, dispersal of sediment and sludge with high concentrations of dioxin is the exposure pathway of concern, and the objective of S/S would be to bind the solid particles to prevent their resuspension and movement from a confined area.

In situ S/S could potentially be used as an alternative to capping to reduce the potential mobility of the sediment. Excess water significantly interferes with the ability of pozzolonic materials to cure, precluding the in situ use of S/S entirely, or reducing the strength and durability of the material stabilized in situ. To effectively perform in situ S/S, containment structures would likely need to be erected and the overlying water removed from the affected area before the surficial material could be stabilized. Stabilization of deeper material is expected to be possible by using specialized equipment.

Ex situ S/S could be used to dewater and stabilize dredged sediment and sludge. The stabilized sediment could be managed on-site or at an industrial waste landfill. For disposal of the sediment and sludge at an industrial landfill, stabilization might not be required, but dewatering is expected to be necessary. This form of treatment would require establishing a temporary processing facility where dredged material would be partially dewatered, mixed with solidification reagents, and conveyed to disposal cells on-site or loaded onto trucks for disposal at a commercial landfill.

Solidification may be performed with pozzolonic materials (e.g., Portland cement, fly ash), a mixture of asphalt and lime (OTA 1991), or other reagents. S/S tends to be the most cost-effective treatment technology available, with historic treatment costs estimated to be in the range of \$5 - \$20 per ton (1991 dollars) based on the OTA report (OTA, 1991) and \$50 to \$310 per ton based on more recent data (USEPA 1997).

### **3.3.3 Dehalogenation**

Chemical dehalogenation of dioxins has been demonstrated in bench-scale studies and limited pilot studies (USEPA 2005b). Limited full-scale treatment has been used with persistent chlorinated compounds (pesticides and polychlorinated biphenyls) that are similar to dioxins (Rogers, et al. 1991).

One process uses heat and a combination of alkali metal (sodium or potassium) hydroxide and polyethylene glycol chlorine atoms from the base dibenzodioxin molecule (Rogers, et al. 1991 and USDOE 2003). This process is commonly identified as APEG or KPEG (specific to the use of potassium hydroxide and polyethylene glycol). The treatment reduces the chemical risk associated with polychlorinated dibenzodioxins, but the reagents are deactivated by water, making it inappropriate for use in situ or with wet sediment or sludge (OTA 1991).

USEPA developed an improved process, base catalyzed decomposition (BCD), which uses less costly reagents that are not deactivated by water (Rogers, et al. 1991 and OTA 1991). In the first stage of BCD, heat is applied to the waste or environmental medium to vaporize the organic contaminants, which are then condensed into an oil solution. In the second stage of

the process, sodium hydroxide and a catalyst are used to dechlorinate the dioxin (USEPA 2005b). BCD has been demonstrated at the bench-scale, but widespread use of the technology at commercial scale is not documented. USEPA estimated that full-scale treatment costs using BCD would be approximately \$245 per ton in 1991 dollars (OTA 1991), and more recent data suggests the cost range could be \$225 to \$580 per ton (USEPA 1997) – however, due to limited demonstrated experience on full-scale treatment of dioxin-contaminated sediments, bench-scale studies would likely be required to determine the effectiveness of BCD at the Site.

BCD is sensitive to the high moisture content of soils (USEPA 1997), which would be an issue for Site sediments. It also produces residuals and off-gasses that must be treated and managed, and is sensitive to soil grain size (USEPA 1997).

Chemical dehalogenation is considered inappropriate for the TCRA for several reasons, with the primary disadvantage being the time required to design and assemble a treatment system. Unlike the other potential treatment technologies evaluated, there are no known operating facilities to perform this treatment in the United States and no precedent for setting up a temporary treatment facility. In addition, the effectiveness of this technology has not been demonstrated in full-scale operation for dioxin-containing sediments.

### **3.4 Summary of Retained Technologies**

Based on this initial screening, the following technologies were retained for detailed evaluation:

- Isolating the Site from land access using fencing (implemented and in place)
- Removing the waste and sediments by dredging
- Confining removed waste and sediments in the upland portion of the waste pit
- Covering the waste and sediments with granular materials
- Covering the waste and sediments with man-made materials
- Isolating the waste and sediments on-site from the river using sheet piling

Five removal action alternatives were developed in consultation with USEPA based on combinations of these technologies, and considering the design criteria discussed in Section 4.



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## **4 DESIGN CRITERIA AND GUIDANCE USED TO DEVELOP ALTERNATIVES**

This section describes the design assumptions that were used in assembling and evaluating the TCRA alternatives.

### **4.1 TCRA Time Frame**

The TCRA is the initial action that will occur at the Site, and is expected to be followed by future actions, including a NTCRA associated with the RI/FS being conducted at the Site. As such, the TCRA is an interim remedy that will serve its primary function for an expected 5- to 7-year timeframe before future actions are implemented at the Site. As described in Appendix C, OM & M costs are computed based on an expected 7-year TCRA duration.

### **4.2 Water Levels**

The primary forces that the TCRA must resist are the hydrodynamic loads from the river system. The magnitude of these forces is related to runoff in the San Jacinto drainage basin north of the Site. The predominant forces develop from increased velocities and bed shear stress that result from a flood event. To a lesser extent, the Site is affected by daily tidal cycles, wind, and passing vessel wakes.

Appendix A presents a discussion of the design storm event. Table 1 presents a summary of water levels for a variety of conditions based on the hydrodynamic modeling summarized below and described in detail in Appendices A and B. All water levels and elevations discussed in this report are presented in the project vertical datum, which is the North American Vertical Datum of 1988 (NAVD 88).

### **4.3 Hydrodynamic Modeling**

To understand the Site-specific hydrodynamic loading that can be expected under a variety of flow conditions, a detailed model was developed for the Site. The details of this model are described in Appendix B. The results of the model are used in conjunction with USEPA and United States Army Corps of Engineers (USACE) guidance (USEPA 2005; USACE 1998) to predict river bed shear stresses, which, in turn, are used to predict scour potential and to select appropriate-sized aggregates for granular covers described in Section 3. The

hydrodynamic model also provides predicted water surface elevations under a variety of conditions. Water levels for selected model scenarios are summarized in Table 1.

#### **4.4 Reference Guidance**

There are several relevant guidance documents published by USEPA and USACE for the selection and design of appropriate remedial strategies for sediment sites. The following documents were considered when assembling alternatives for the TCRA:

- *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*, USEPA, December 2005
- *USEPA Guidance for In-Situ Subaqueous Capping of Contaminated Sediments (ARCS Program)*, Palermo et al., 1998
- *Guidance for Subaqueous Dredge Material Capping*, USACE, June 1998
- *Technical Guidelines for Environmental Dredging of Contaminated Sediments*, USACE, September 2008

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## 5 DESCRIPTION OF ALTERNATIVES CONSIDERED

### 5.1 Alternative 1 – Sheet Pile and Granular Cover

Alternative 1 entails the following major elements (Figure 3):

- Construction of a security fence on the uplands to prevent unauthorized access to the Site (completed April 29, 2010).
- Construct an access road and laydown pad.
- Construction of a sheet pile isolation wall around the impoundment alignment.
- Installation of granular cover within the contained area.
- Protection of the shoreline of the Western Cell with geotextile and granular cover.
- Repair areas of damaged vegetation in the Western Cell with geotextile and granular cover.
- Use of appropriate health and safety and environmental control measures during construction.

Figures 4 and 5 present representative cross sections for Alternative 1. Due to the shallow water in the Eastern Cell, the sheet pile cannot be installed using a conventional barge and pile-driving setup. To construct the sheet pile in this area, an access road or rock platform would be built along the centerline of the sheet pile alignment by end-dumping aggregate from shoreline, and progressively working into the water. The access road would be of sufficient elevation and width to allow the pile-driving equipment to safely work. Based on conversations with local contractors about this approach, the road would have a crest width of 18 feet at an elevation of 2 feet NAVD88.

In the deep-water area of the sheet pile alignment, the sheet pile would be installed from a barge. The sheet pile would have significant unsupported height above the mudline, and thus would be buttressed on both sides by a rock revetment mound to provide lateral support.

The sheet pile would have a top elevation of 4 feet NAVD88. Weep holes would be installed in the sheet pile to allow the river elevation to equalize on both sides of the sheet pile,

preventing the development of an unbalanced hydrostatic pressure that could compromise the integrity of the wall.

As described in Section 3.2.3, the sheet pile material assumed for the conceptual alternative is composite. There is some concern about the ability to drive this material through the rock platform, and any potential effects this activity might have on the durability of the composite material. As discussed subsequently, it could be determined during detailed design that a steel material would be required.

Because the wall would be overtopped in the design storm event, granular cover would be placed within the contained perimeter of the sheet pile. The granular cover gradation would be specified to prevent loss of cover during the design storm event, and corresponds with a coarse gravel material. The granular cover design thickness is based on at least two times the median diameter ( $D_{50}$ ) of the cover material, and for costing purposes has an assumed thickness of 6 inches, with a 6-inch overplacement allowance. It would be placed from the shore by building a road out into the water using the granular material, and progressively working from the end of the road back to shore with an excavator. The excavator would work by cutting the road down and side casting the road material to the required cover thickness on each side of the road. In the deeper water areas, the granular cover would be placed from a barge.

The high ground in the Western Cell is currently vegetated. The presence of this vegetation acts to stabilize Site soils. Research on the effect of vegetation indicates that the presence of grasses and trees provides significant resistance against shear stress (Fishchenich 2001). The presence of vegetation is expected to stabilize Site soils under the full range of storm conditions considered for the Site. Where vegetation is disturbed during TCRA construction, the area will be repaired by covering the disturbed area with a geotextile and granular cover.

### **5.1.1 Data Gaps for Alternative 1**

Existing bathymetry data was not collected at sufficient density to completely understand the contours of the western shoreline or the nature of the deep channel in the submerged

northwestern portion of the Site. To develop this alternative beyond conceptual design, additional bathymetry data is required.

In addition, the hydrodynamic model described in Appendix B would be improved if Site-specific data were available to calibrate the model. To collect this data, an acoustic Doppler current profiler (ADCP) would be deployed at the Site to measure currents.

## **5.2 Alternative 2 – Sheet Pile, Granular Cover, Dredge, and Revetment**

Alternative 2 entails the following major elements (Figure 6):

- Construction of a security fence on the uplands to prevent unauthorized access to the Site (completed April 29, 2010).
- Construct an access road and laydown pad.
- Construction of a sheet pile isolation wall around the Eastern Cell.
- Installation of granular cover within the contained area.
- Dredging of the deep water in the northwestern corner of the Site.
- Consolidation of dredge material in geotubes staged on the high ground in the Western Cell.
- Protection of the shoreline of the Western Cell with a rock revetment and an aggregate berm.
- Repair areas of damaged vegetation in the Western Cell with geotextile and granular cover.
- Use of appropriate health and safety and environmental control measures during construction.

Figures 7 and 8 present cross sections for Alternative 2. As with Alternative 1, a rock platform would be built in the shallow water to facilitate sheet pile installation, and in the deeper water the sheet pile would be installed from a barge. Where the unsupported height of the sheet pile wall is significant, a rock buttress would be used to provide additional lateral support. Other details, such as top elevation and the use of weep holes to equalize water pressure are the same as for Alternative 1.



Granular cover would be used in Alternative 2 in the same fashion as Alternative 1.

Alternative 2 includes dredging of the deeper water area in the northwest corner of the Site. A small hydraulic dredge would be used to remove the surface material. Dredge material would be pumped into geotubes located on the high ground in the Western Cell where it would dewater and consolidate. A dredge cut thickness of 18 inches has been assumed in this alternative, with an overdredge allowance of 6 inches.

The north slope of the Western Cell would be protected with a rock revetment. Rock would be appropriately sized to withstand hydrodynamic loads from the design-level event. At the top of the slope in this area, an aggregate berm would be constructed to prevent water from entering the Western Cell during normal tidal cycles. This berm would be constructed to elevation 4 NAVD88.

#### **5.2.1 Data Gaps for Alternative 2**

As with Alternative 1, bathymetry would need to be updated to develop the design for this alternative, and the hydrodynamic model could be improved by collecting Site-specific current data with an ADCP.

This alternative includes dredging of the deep-water area in the northwestern corner of the Site. Another data gap is the depth profile of contamination. The decision to include this area in the TCRA is based on a review of chemistry results from surface grab samples. In order to design the dredge prism and to set the appropriate required dredge depth, additional data would need to be collected to determine the vertical extent of contamination in this area.

In addition to sediment chemistry, the dewatering behavior of the proposed dredge sediment is unknown. To evaluate the use of geotubes for dewatering, a hanging bag test would be required.

### **5.3 Alternative 3 – Granular Cover and Revetment**

Alternative 3 entails the following major elements (Figure 9):

- Construction of a security fence on the uplands to prevent unauthorized access to the Site (completed April 29, 2010).
- Construct an access road and laydown pad.
- Construction of a rock cover perimeter around the Eastern Cell.
- Installation of granular cover within the rock perimeter of the Eastern Cell.
- Installation of granular cover over the northwestern corner of the Site.
- Protection of the shoreline of the Western Cell with a rock revetment and an aggregate berm.
- Repair areas of damaged vegetation in the Western Cell with geotextile and granular cover.
- Use of appropriate health and safety and environmental control measures during construction.

Figures 10 and 11 provide representative cross sections showing the detail of Alternative 3. The rock perimeter berm would be at least 2 feet thick. However, in the deep channel along the north side of the Site, additional rock would be placed to provide a hydraulic cutoff of this channel. The additional rock fill would be placed to a top elevation of -2 feet NAVD88, consistent with the majority of the rock perimeter fill.

Granular cover, 6 inches thick (with an overplacement allowance of 6 inches), would be placed within the limits of the rock perimeter, and in the deep water in the northwestern corner of the Site. A rock revetment and aggregate berm would be constructed to protect the slope of the Western Cell, as described in Alternative 2.

### **5.3.1 Data Gaps for Alternative 3**

Alternative 3 would require updated bathymetry, as described for Alternative 1. The hydrodynamic model could be improved by collecting Site-specific data using ADCP.

## **5.4 Alternative 4 – Rock Berm, Granular Cover, and Revetment**

Alternative 4 entails the following major elements (Figure 12):

- Construction of a security fence on the uplands to prevent unauthorized access to the Site (Completed April 29, 2010).
- Construction of an access road and laydown pad.
- Construction of a rock berm perimeter around the Eastern Cell.
- Installation of granular cover within the rock berm.
- Installation of granular cover over the northwestern corner of the Site.
- Protection of the shoreline of the Western Cell with a rock revetment and an aggregate berm.
- Repair areas of damaged vegetation in the Western Cell with geotextile and granular cover.
- Use of appropriate health and safety and environmental control measures during construction.

Figures 13 and 14 provide representative cross sections showing the details of Alternative 4. The major elements of Alternative 4 are similar to Alternative 3, with the exception of the perimeter berm around the Eastern Cell. This berm, constructed of rock, would be constructed to elevation 1 foot NAVD88 and would serve to minimize hydrodynamic forces on the cover during normal tides. In addition, the berm would impede access to the Site by boats.

#### **5.4.1 Data Gaps for Alternative 4**

Alternative 4 would require updated bathymetry, as described for Alternative 1. The hydrodynamic model could be improved by collecting Site-specific data using ADCP.

### **5.5 Alternative 5 – ACBM and Dredge**

Alternative 5 entails the following major elements (Figure 15):

- Construction of a security fence on the uplands to prevent unauthorized access to the Site (completed April 29, 2010)
- Construction of an access road and laydown pad

- Installation of ACBM over the Eastern Cell.
- Dredging of the deep water area in the northwestern corner of the Site.
- Consolidation of dredge material within geotubes staged on the high ground of the Western Cell.
- Protection of the shoreline of the Western Cell with an aggregate berm at the top of the slope, and either ACBM or rock on the slope.
- Repair areas of damaged vegetation in the Western Cell with geotextile and granular cover.
- Protection of the submerged outer edge of the ACBM with a rock scour apron.
- Use of appropriate health and safety and environmental control measures during construction.

Figures 16 and 17 provide representative cross sections showing the details of Alternative 5. Following completion of dredging in the northwestern area, ACBM would be installed to stabilize sediments in the Eastern Cell. The ACBM would be underlain by a geotextile fabric to facilitate installation and provide another layer of containment for the covered sediments. The installation process would require a skilled crew to pull the geotextile fabric form into its desired configuration using boats, cables, and winches above or at the water surface. Once in position, the fabric form would be sunken below the water surface and pumped full with lean grout to form the concrete pillow structure.

Each panel of the ACBM would be overlapped appropriately to ensure complete coverage of the surface. Panels would be lapped in a shingle-like fashion so that river currents would not undermine the panel overlap. Once all of the ACBM panels are in position, the submerged outer edge of the ACBM would be protected by covering it with a rock scour apron to prevent undermining of the ACBM system.

### **5.5.1 Data Gaps for Alternative 5**

Data gaps for Alternative 5 are the same as for Alternative 2. Updated bathymetry would be required, and information on the vertical extent of contamination, as well as geotube

dewatering, would need to be collected. In addition, the hydrodynamic model would benefit from Site-specific data collected using ADCP.



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## **6 COMPARATIVE EVALUATION OF ALTERNATIVES**

This section presents a comparative evaluation of the five alternatives described in Section 5, considering the criteria described in Section 2. Table 2 presents a summary matrix of this comparative evaluation, with detailed considerations discussed below.

### **6.1 Effectiveness**

#### **6.1.1 *Effectiveness at Isolating Target Sediments***

Each alternative can be designed with appropriately-engineered materials to resist the hydrodynamic forces acting on the Site for the design-level weather event. The initial technology screening presented in Section 3 did not consider any alternatives that would be ineffective in achieving one of the primary goals of the TCRA. Thus, all of the alternatives are considered as being equally effective at isolating the target sediments.

#### **6.1.2 *Effectiveness at Withstanding Extreme Weather Events***

As described above, each alternative would be designed to withstand the design-level weather event according to USEPA and USACE guidance. Thus each alternative ranks equally in effectiveness for this criterion.

#### **6.1.3 *Effectiveness at Preventing Benthic and Human Contact***

Each alternative uses a proven technology and can be designed to meet the TCRA requirement for preventing both benthic and human contact. Thus, each alternative ranks equally in effectiveness for these criteria.

#### **6.1.4 *Potential Impacts to Human Health and the Environment during Construction***

Alternatives 1 and 2 include the use of a composite sheet pile material. In order to drive or vibrate a composite sheet pile, a steel mandrel is used to advance the sheets below the mudline. Once the sheet has reached tip elevation, the mandrel is released from the sheet and it is withdrawn from below the ground surface and re-used for the next sheet installation.

Depending on the length of the sheet pile wall, the mandrel would be driven and withdrawn between 500 and 750 times to install the sheet pile. Each time the mandrel is withdrawn; there is some risk of resuspension of contaminated sediments. The construction of the rock platform for the sheet piles will help control the resuspension of contaminated sediments on the mandrel. Compared to Alternatives 3, 4, and 5, Alternatives 1 and 2 have a higher risk of construction-related environmental impacts.

The sheet pile installation also requires heavy equipment and overhead loads. Compared to Alternatives 3, 4, and 5, Alternatives 1 and 2 pose a higher risk to worker health and safety during construction.

Alternatives 2 and 5 include dredging and consolidation of dredge material within the Western Cell. Dredging has an inherent risk for sediment resuspension and residuals generation (USEPA 2005; USACE 2008a). Compared to Alternatives 1, 3, and 4, Alternatives 2 and 5 have a moderately higher risk for environmental impacts related to construction. Water quality impacts would need to be minimized by employing appropriate best management practices (BMPs) for dredging, and by monitoring water quality during construction.

#### **6.1.5 Compatibility with Future Actions at the Site**

Analogous to the discussion in Section 3, there are three general categories of future actions that could be taken to address environmental risks at the Site once the TCRA has been completed. These categories are: 1) removal; 2) containment; and 3) treatment. Each alternative has been evaluated to consider its potential compatibility with these three future categories of actions. Table 3 summarizes the results of this evaluation and provides a relative ranking of the alternative for both the Eastern and Western Cells, according to the following system:

- Lowest compatibility
- Low to moderate compatibility
- Moderate to high compatibility
- Highest compatibility

#### **6.1.5.1      *Future Removal Activities***

All alternatives entail placing granular material or concrete mat across the Eastern Cell. Alternatives 1 and 2 also entail construction of a sheet pile wall in this area. Because the granular cover would need to be excavated for a future removal activity, Alternatives 3 and 4 rank “low to moderate” compatibility for the Eastern Cell. In addition to the granular material, Alternatives 1 and 2 would require removal of the sheet pile wall and access road. The sheet pile removal would cause significant disturbance to existing sediments. Thus, these alternatives rank “lowest” compatibility for future removal activities in the Eastern Cell. Finally, the ACBM would present a substantial challenge to a future removal activity because the concrete would need to be demolished, a construction challenge that would likely cause substantial disturbance to sediments beneath the ACBM cover. Alternative 5 thus ranks “lowest” for compatibility with a future removal activity in the Eastern Cell.

In the Western Cell, all alternatives entail repair of damaged vegetation with a geotextile and granular cover. In addition, Alternatives 2 and 5 include dredging with dredge material consolidation in the Western Cell. Because of the expected moderate amount of filling that might be necessary in Alternatives 3 and 4, these alternatives rank “moderate to high” for compatibility with a future removal action in the Western Cell. Alternatives 2 and 5, because they would contain a rock revetment or ACBM and dredge material after the TCRA was completed, rank “lowest” for compatibility with a future removal activity. Alternative 1, because of the sheet pile wall and granular fill that would need to be removed, ranks “lowest” for compatibility with future removal.

#### **6.1.5.2      *Future Containment Activities***

Alternatives 1 and 2 entail construction of a sheet pile wall around the Eastern Cell. Construction of a future containment action would likely require the sheet piles to be removed. Thus, these alternatives rank “low to moderate” for compatibility with future containment actions. Alternatives 3 and 4 include placement of granular cover over the Eastern Cell. It is expected that a future containment activity in this area would also entail placement of cover material, which could be built on top of the TCRA surface with little expected difficulty. Thus, Alternatives 3 and 4 rank “highest” for compatibility with future containment activities in the Eastern Cell. The ACBM placed in the Eastern Cell under

Alternative 5 would likely be compatible with a future containment action; however, there might need to be some detail work and/or selective demolition at transition points to facilitate construction of a future containment system. Thus, Alternative 5 ranks “moderate to high” for compatibility with future containment in the Eastern Cell.

Alternative 1, in the Western Cell, would potentially require the sheet pile wall to be removed to facilitate a future containment activity. Thus, this alternative ranks “low to moderate” for compatibility. Alternative 2 includes dredging, with consolidation of dredge material on the high ground of the Western Cell. This area would potentially require modification and/or selective demolition to facilitate future containment. Thus, Alternative 2 ranks “low to moderate” for compatibility. As with the Eastern Cell, Alternatives 3 and 4 include placement of granular cover that could be integrated with a future containment activity relatively easily. Thus, these alternatives rank “highest” for compatibility for future containment. Finally, Alternative 5 considerations for ACBM in the Western Cell are the same as for the Eastern Cell. This factor, as well as the presence of consolidated dredge material on the high ground of the Western Cell (as in Alternative 2), leads to a ranking of “low to moderate” for compatibility with future containment activities.

#### **6.1.5.3      *Future Treatment Activities***

Future treatment activities, if identified as appropriate for the Site, would require demolition of the sheet piles used for Alternatives 1 and 2 in the Eastern Cell. In addition, the granular cover is additional fill material that would require treatment. Thus, both alternatives rank “lowest” for compatibility with future treatment actions in the Eastern Cell. The granular cover in Alternatives 3 and 4 (as with Alternatives 1 and 2) is additional material requiring treatment in the Eastern Cell, and thus these alternatives rank “low to moderate” for compatibility with future treatment actions in this area. The ACBM in Alternative 5 would prevent most treatment from being performed without significant demolition of the ACBM being done. This alternative ranks “lowest” for compatibility with future treatment.

In the Western Cell, Alternative 1 includes a sheet pile wall that would need to be removed to facilitate future treatment activities, and granular cover that would need to be incorporated into the treatment activity. Alternative 2 includes shoreline armoring and

consolidation of dredge material on the high ground of the Western Cell. Both of these alternatives rank “lowest” for compatibility with future treatment activities. Alternatives 3 and 4 entail placement of granular cover which would need to be managed as part of treatment and thus rank “low to moderate” for compatibility.

### **6.1.6 Effectiveness Summary**

The following is a summary of the effectiveness evaluation:

- Isolating target sediments: All alternatives rank equally.
- Withstanding extreme weather events: All alternatives rank equally.
- Preventing benthic and human contact: All alternatives rank equally.
- Impacts during construction: Alternative 5 ranks highest (the least likely to produce adverse impacts during construction). Alternatives 3 and 4 rank slightly lower. Alternatives 1 and 2 rank lowest.
- Compatibility with future actions at the Site: Alternative 3 ranks highest. Alternative 4 ranks slightly lower.

## **6.2 Implementability**

Implementability considerations are summarized in Tables 4 and 5, and are discussed in detail in this section.

### **6.2.1 Availability of Labor, Equipment, and Materials**

Implementability considers the availability of labor, equipment, and materials to complete the work. With regard to labor and equipment, all of the construction activities described in the alternatives can be completed with locally-available, experienced resources. Alternatives 1 and 2 include composite sheet pile installation. Sheet pile installation will require the use of specialized labor and equipment to install. Composite sheet piles are available from a specialized supplier and have a lead time of approximately 2 to 3 weeks. All alternatives include the use of larger-sized natural stone. This material is not locally available and needs to be shipped in by barge. Delivery lead times for this material are expected to range from 6



to 8 weeks. Alternative 5 uses ACBM, which may require a custom template to be developed to match Site bathymetry and panel layout. This could require a lead time of 4 to 8 weeks.

Because lead times are comparable, all alternatives are considered to rank equally for this implementability consideration.

### **6.2.2 Construction Considerations**

Table 5 summarizes constructability considerations for each alternative. For Alternatives 1 and 2, the sheet pile installation will require heavy equipment, a specialized contractor, and construction of a rock platform in the shallow water to facilitate the installation of the wall. Both alternatives also require shallow water placement of granular cover, which would require careful sequencing and consideration for placement.

Alternatives 2 and 5 include dredging, which would require a specialized contractor and make use of the high ground area of the Western Cell for dredge material consolidation with a geotube dewatering system. While the use of hydraulic dredging and geotube dewatering is well demonstrated and commonly used, these techniques would not necessarily be familiar to a typical earthwork contractor.

Alternatives 3 and 4 also include shallow-water placement of granular fill material, and similar constructability considerations apply for these alternatives as for Alternatives 1 and 2.

Alternative 5 includes the specialized construction of ACBM placement. Accurate ACBM placement can be a challenge in river currents. If defects occur during construction (e.g., incomplete grout fill, geotextile damage, or incomplete overlap) they can be very difficult to correct. Finally, the ACBM installation process is most efficient with a large upland laydown area to spread the geotextile prior to placing it into the river.

### **6.2.3 Navigation and/or Flood Control Impacts**

Alternatives 1 and 2 include construction of a rigid structure (sheet pile wall) to elevation 4 feet NAVD88. At higher river stages, wayward vessels could ground on the wall. At lower river stages, vessels could collide with the wall, causing damage to the wall and/or the vessel.

Alternative 4 includes a rock berm to elevation 1 foot NAVD88, which would require signage to alert vessels to the presence of the berm, and would be a hazard to navigation. Alternatives 3 and 5 have the least modification to the profile of the river bed and would have the smallest effect on flood capacity of the river system. Alternatives 1, 2, and 5 result in a hard surface within the river channel (either vertical or horizontal), while Alternatives 3 and 4 rely on a “softer” material.

Alternatives 1 and 2 would likely have the greatest impact on flood flow in the river because they are built to the highest elevation. The sheet pile wall in these alternatives also narrows the channel greater than Alternatives 3, 4, and 5, which would likely result in an increase in current speed near the Site for Alternatives 1 and 2. Compared to the other alternatives, Alternatives 1 and 2 are expected to have the greatest potential impact on downstream structures near the Site, such as the I-10 Bridge, because the channel cross section is narrowed the most. These factors would need to be further evaluated in detail during final design.

#### **6.2.4      *Estimated Duration of Project***

Table 4 summarizes the estimated duration of the project. The alternatives are expected to take from 2.6 to 6.1 months to complete, after mobilization has started. There is a preference for alternatives that can be completed in a shorter timeframe.

#### **6.2.5      *Implementability Summary***

The following is a summary of the implementability evaluation:

- Availability of labor, equipment, and materials: Alternatives 1, 2, and 5 require additional specialty trades compared to Alternatives 3 and 4. All alternatives have similar lead times for aggregates. Alternative 5 has a potential long lead time for the ACBM material.
- Construction considerations: All alternatives are challenged by the shallow water environment. Alternative 5 has additional considerations for ACBM installation, with potential challenges associated with river currents, and the issue that repairs, if necessary, are difficult

- Navigation and/or flood control impacts: Alternatives 1 and 2 provide the highest potential impact for navigation and flood control issues, and the highest potential impact on downstream structures near the Site, such as the I-10 Bridge.

## **6.3 Cost**

### **6.3.1 Cost Analysis**

Estimated costs were developed for each alternative using information collected by contacting various suppliers and contractors, and using best professional judgment for items where prior experience provided a rational basis for the estimate (e.g., design and monitoring costs). Table 6 presents a summary of the estimated cost for each alternative. Appendix C presents details of the cost estimates, including backup information for unit cost and quantity estimates. Costs include the following major elements:

- Construction Costs
  - Mobilization, demobilization, and Site preparation
  - Construction of stabilization measures
  - Environmental controls and survey
- Non-Construction Costs
  - Contingency
  - Design, construction management, and environmental monitoring during construction
  - Operations, monitoring, and maintenance

The target accuracy for the conceptual-level estimates is to be within +/- 30 percent of actual cost based on feedback from USEPA. Each alternative was estimated to the same level of accuracy, thus the relative difference in cost for each alternative would be similar if the assumptions for the estimates were either more or less accurate.

### **6.3.2 Cost Risk**

Alternatives 1 and 2 include a sheet pile wall. For these alternatives, it has been assumed that a lower-cost composite sheet pile section would be used. As previously described, there is some risk with using a composite sheet pile during installation (uncertainty if the sheet pile can be driven through the rock platform), and from impact damage due to river vessel traffic. If it is determined during detailed design or construction that these risks are unacceptable or that the sheet piles cannot be driven through the rock platform, a steel sheet pile would need to be substituted for composite material, at a significantly higher cost. The estimated additional cost for using steel sheet piles as a substitute for composite sheet piles is \$1.7 million and \$1 million for Alternatives 1 and 2, respectively. In addition to cost risk, the lead time for steel sheet could be as much as 4 months, depending on the type of sheet required.

### **6.3.3 Cost Summary**

Alternative 3 is the most cost-effective alternative, at roughly 51 to 88 percent of the cost of the other alternatives, not considering the cost risks discussed above.

---

## 7 RECOMMENDED ALTERNATIVE

Based on the evaluation criteria established in Section 2, Alternative 3 is the preferred alternative for the following reasons:

- Alternative 3 is equally effective as the other alternatives in preventing erosion of the sediments, and is equally effective at preventing benthic and human contact
- Alternative 3 will be capable of withstanding the design storm event. The hydrodynamic modeling provides the proper sizing for aggregate that would be used to resist the design-level storm event.
- Alternative 3 has minimal potential for disturbance (resuspension of contaminated materials) during construction. Any potential for resuspension would be managed with appropriate environmental controls, BMPs, and monitoring
- Alternative 3 also has the least amount of conflicts with any of the range of potential NTCRA technologies, allowing more flexibility with NTCRA selection and design
- Alternative 3 has fewer potential impacts to navigation and flood flow than any of the other alternatives, excluding ACBM, due to its lower profile in the river
- Alternative 3 can be completed in approximately 3 to 4 months
- Alternative 3 is approximately 51 to 88 percent of the cost of the other alternatives

As discussed under the description for Alternative 3, two data gaps were identified for design of the TCRA: 1) Site-specific river current data; and 2) updated bathymetry. Appendix D presents a Sampling and Analysis Plan as required by the AOC (USEPA 2010, Appendix D) to address these data gaps through the deployment of an ADCP, and by collecting additional bathymetric survey data at the Site.

---

## 8 REFERENCES

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## TABLES

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**Table 1**  
**Water Levels Expected at the Site**

| <b>Condition<sup>1,2</sup></b> | <b>Elevation<sup>3</sup></b> |
|--------------------------------|------------------------------|
| Mean Higher High Water         | 1.5                          |
| Mean High Water                | 1.4                          |
| Mean Tide Level                | 0.83                         |
| Mean Low Water                 | 0.22                         |
| Mean Lower Low Water           | 0.05                         |
| 5-year storm                   | 6.3                          |
| 10-year storm                  | 8.1                          |
| 25-year storm                  | 10.3                         |
| Hurricane Ike                  | 11.0                         |

1 – Tidal elevations based on Battleship Texas State Park gage

2 – Storm and hurricane elevations based on hydrodynamic modeling (see Appendix B)

3 – All elevations presented in feet, NAVD 88 vertical datum

**Table 2**  
**Effectiveness Evaluation of Alternatives**

| Criteria                                    | Alternative 1   | Alternative 2   | Alternative 3   | Alternative 4   | Alternative 5  |
|---|---|---|---|---|--|
| Isolation of sediments                      | All alternatives considered to rank equally. See text.  |   |   |   |  |
| Ability to withstand extreme weather events | All alternatives considered to rank equally. See text.  |   |   |   |  |
| Isolation of sediments from benthic contact | All alternatives considered to rank equally. See text.  |   |   |   |  |
| Isolation of sediments from human contact   | All alternatives considered to rank equally. See text.  |   |   |   |  |
| Impacts during construction                 | <ul style="list-style-type: none"> <li>– Moderate disturbance from sheet pile installation</li> </ul> | <ul style="list-style-type: none"> <li>– Moderate disturbance from sheet pile installation</li> <li>– Potential for dredging-related water quality impacts</li> </ul> | <ul style="list-style-type: none"> <li>– Minimal disturbance during cover installation</li> </ul> | <ul style="list-style-type: none"> <li>– Minimal disturbance during cover installation</li> </ul> | <ul style="list-style-type: none"> <li>– Least disturbance during ACBM installation</li> <li>– Potential for dredging-related water quality impacts</li> </ul> |
| Compatibility with future actions at Site   | See Table 3   |   |   |   |  |

**Table 3**  
**Compatibility of Alternatives with Future Actions**

| Future Action | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 |
|---------------|---------------|---------------|---------------|---------------|---------------|
| Eastern Cell  |               |               |               |               |               |
| Removal       | ●             | ●             | ○             | ○             | ●             |
| Containment   | ○             | ○             | ■             | ■             | □             |
| Treatment     | ●             | ●             | ○             | ○             | ●             |
| Western Cell  |               |               |               |               |               |
| Removal       | ●             | ●             | □             | □             | ●             |
| Containment   | ○             | ○             | ■             | ■             | ○             |
| Treatment     | ●             | ●             | ○             | ○             | ●             |

- Lowest compatibility
- Low to moderate compatibility
- Moderate to high compatibility
- Highest compatibility

**Table 4**  
**Implementability Evaluation of Alternatives**

| Criteria                                | Alternative 1   | Alternative 2 | Alternative 3    | Alternative 4               | Alternative 5                        |
|---|---|---------------|------------------|-----------------------------|--------------------------------------|
| Availability of labor and equipment     | All alternatives considered to rank equally. See text.                                  |               |                  |                             |                                      |
| Availability of materials               | All alternatives considered to rank equally. See text.                                  |               |                  |                             |                                      |
| Construction considerations             | See Table 5.  |               |                  |                             |                                      |
| Navigation and/or flood control impacts | – Sheet pile hazard to navigation<br>– Sheet pile flow constriction<br>– Hard structure |               | – Lowest profile | – Berm hazard to navigation | – Hard substrate<br>– Lowest profile |
| Estimated duration of construction      | 6.1 months  | 4.9 months    | 2.7 months       | 2.6 months                  | 2.6 months                           |

**Table 5**  
**Constructability Considerations for Alternatives**

| Alternative | Description                                   | Construction Considerations  |
|-------------|---|--|
| 1           | Sheet Pile<br>Granular Cover                  | <ul style="list-style-type: none"> <li>– Specialized contractor and heavy equipment for sheet piling</li> <li>– Rock platform necessary for sheet pile installation</li> <li>– Shallow water for granular cover placement</li> </ul>   |
| 2           | Sheet Pile<br>Granular Cover<br>Dredging      | <ul style="list-style-type: none"> <li>– Specialized contractor and heavy equipment for sheet piling</li> <li>– Specialized contractor for dredging</li> <li>– Rock platform necessary for sheet pile installation</li> <li>– Shallow water for granular cover placement</li> </ul>                                  |
| 3           | Granular Cover<br>Rock Revetment              | <ul style="list-style-type: none"> <li>– Shallow water for granular cover placement</li> </ul>   |
| 4           | Rock Berm<br>Granular Cover<br>Rock Revetment | <ul style="list-style-type: none"> <li>– Shallow water for granular cover placement</li> </ul>   |
| 5           | ACBM Cover<br>Dredging                        | <ul style="list-style-type: none"> <li>– Specialized contractor for ACBM</li> <li>– Specialized contractor for dredging</li> <li>– ACBM installation defects hard to correct</li> <li>– Large laydown area may be needed for ACBM staging</li> <li>– River currents can affect accurate placement of ACBM</li> </ul> |



---

**Table 6**  
**Estimated Costs for Alternatives**

| <b>Alternative</b> | <b>Estimated Cost</b> |
|--------------------|-----------------------|
| 1                  | \$5.84M               |
| 2                  | \$5.08M               |
| 3                  | \$3.56M               |
| 4                  | \$4.02M               |
| 5                  | \$6.94M               |

1 – See Appendix C for cost details.

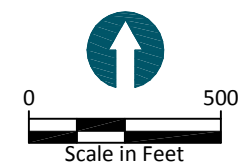
2 – Alternatives 1 and 2 were estimated assuming a composite sheet pile material would be used. If a steel sheet pile were determined to be required during detailed design or construction, the estimated cost would increase by approximately 15 to 30 percent for Alternatives 1 and 2.

## FIGURES

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SOURCE: Google Map Pro 2009



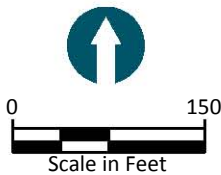


K:\Jobs\090557-San Jacinto\090557-01 - San Jacinto\09055701-RP-038.dwg FIG 2  
May 25, 2010 5:00pm cdavidson



- LEGEND:**
- TCRA Sediment 2, 3, 7, 8-TCDD  
Dry Weight and OC Normalized (ng/kg)
  - Original (1966) Perimeter of the Impoundments

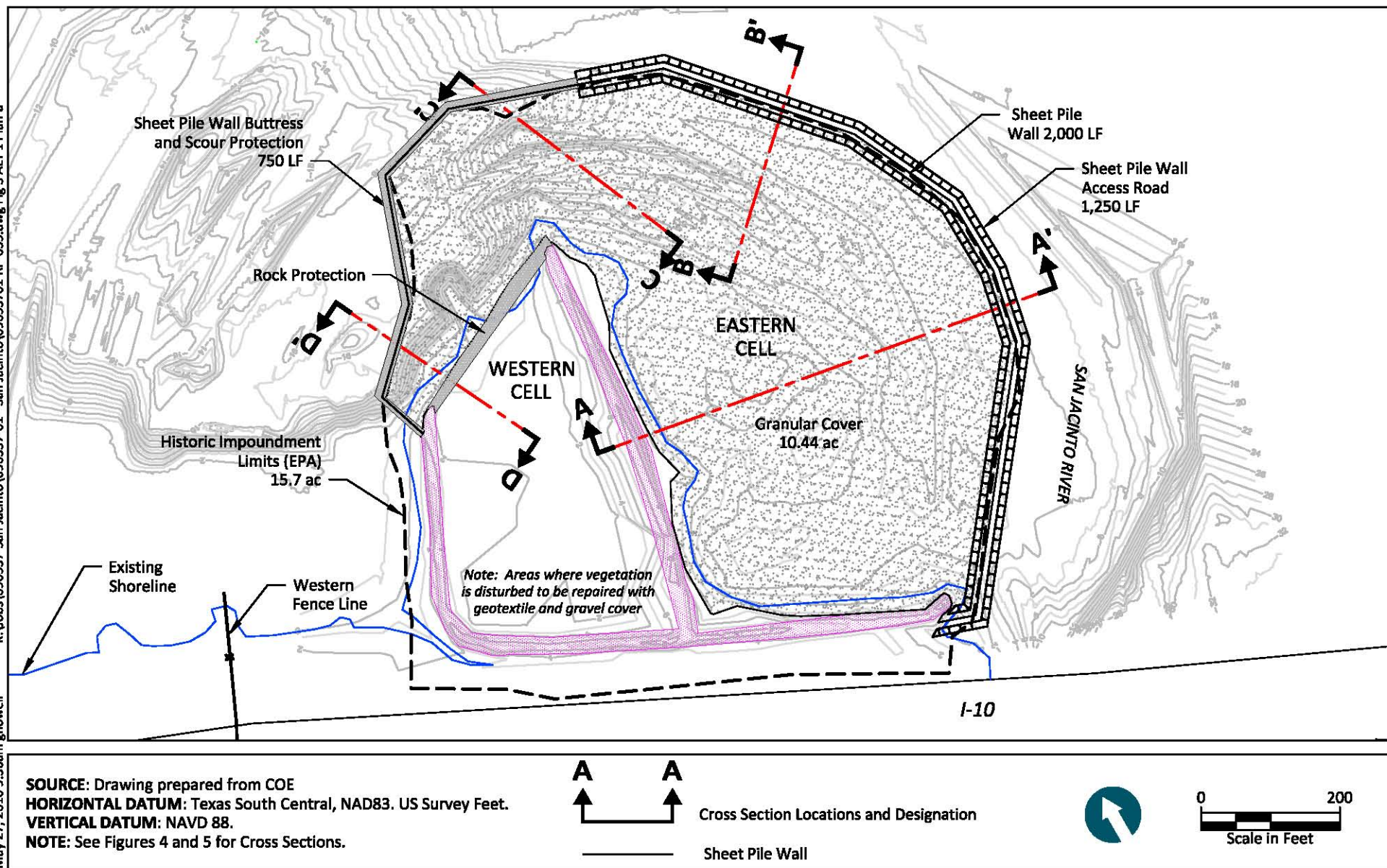
**SOURCE:** Aerial Imagery: 0.5-meter  
January 2009 DOQOs - Texas Strategic  
Mapping Program (StraMap), TNIS



**Figure 2**  
TCRA Sample Locations  
2, 3, 7, 8-TCDD (ng/kg)  
SJRWP TCRA

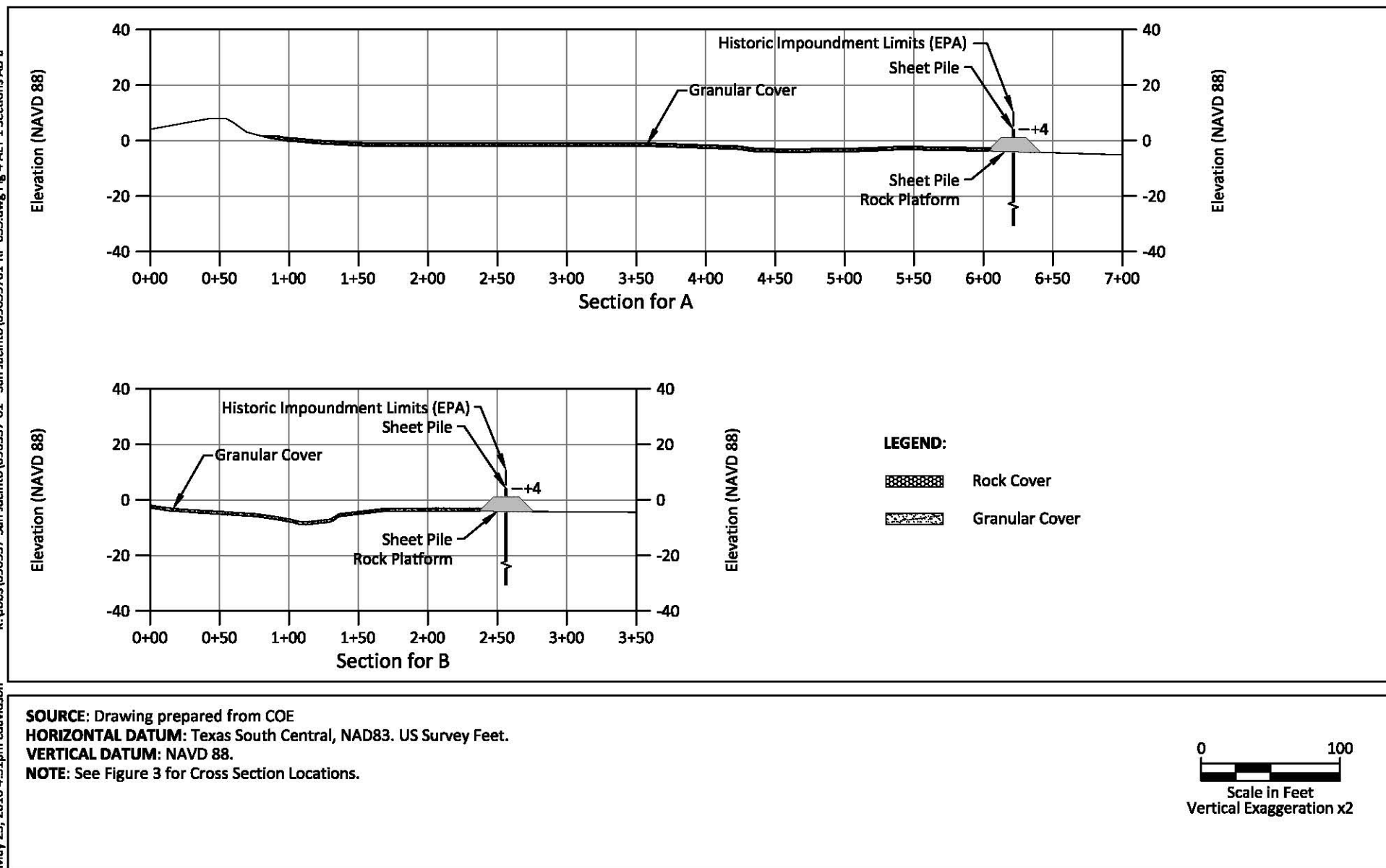


k:\Jobs\090557-San Jacinto\090557-01 - San Jacinto\090557-01-RP-035.dwg Fig 3 ALT 1 Plan-a  
May 27, 2010 9:56am ghowell



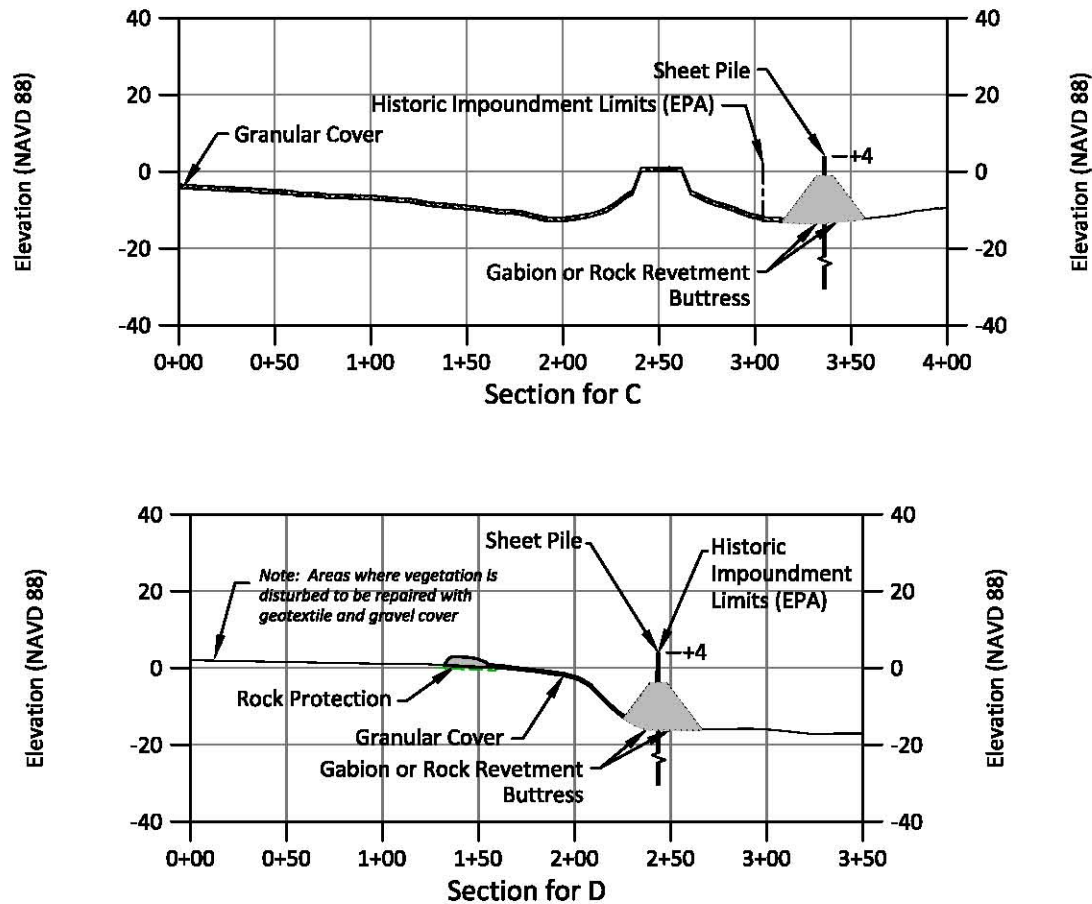
**Figure 3**  
 Alternative 1 Plan View  
 East and West Impoundment Sheet Pile  
 SJRWP TCRA





**Figure 4**  
 Cross Sections A and B - Alternative 1  
 SJRWP TCRA





**SOURCE:** Drawing prepared from COE

**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.

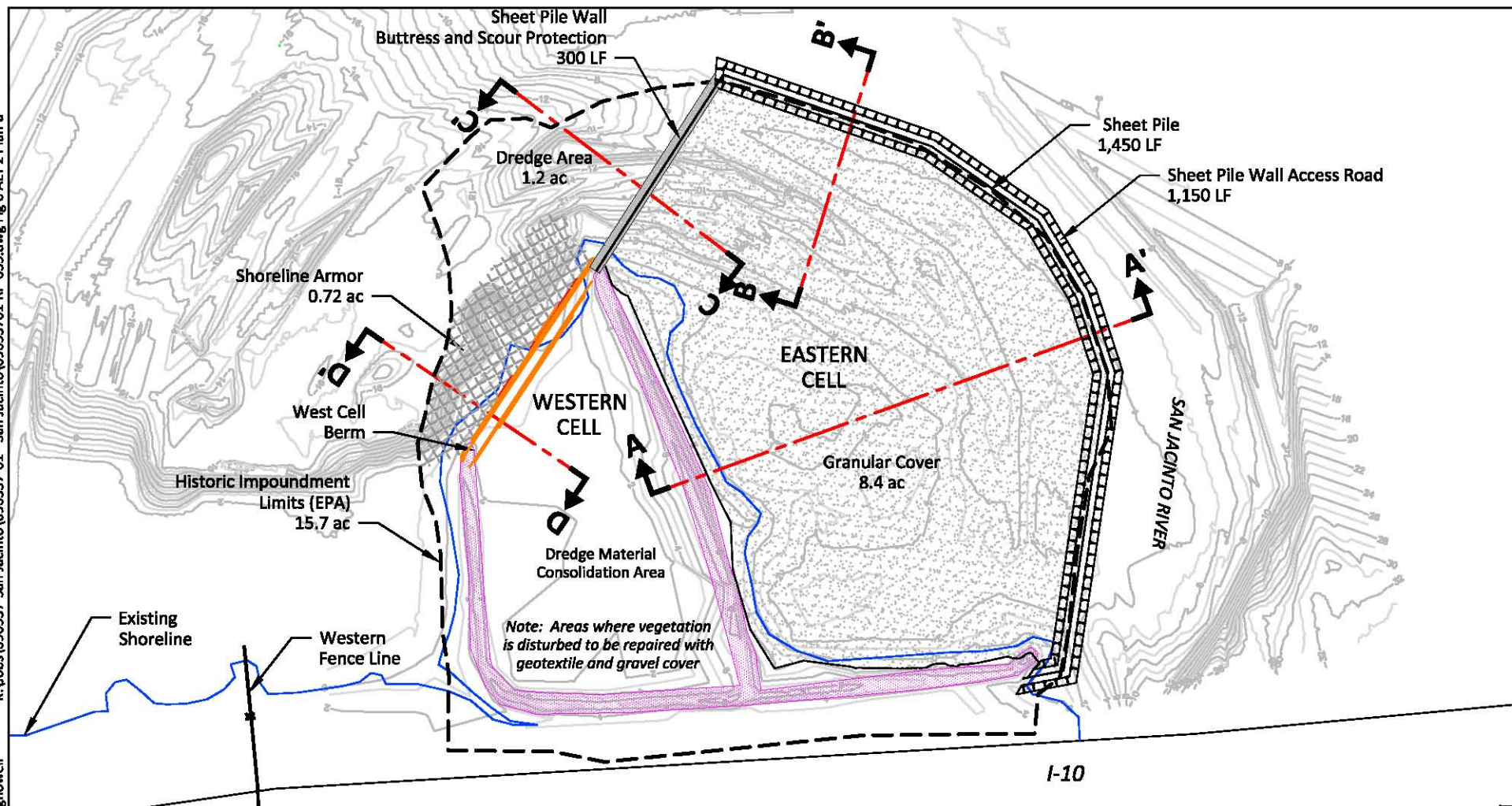
**VERTICAL DATUM:** NAVD 88.

**NOTE:** See Figure 3 for Cross Section Locations.



**Figure 5**  
Cross Sections C and D - Alternative 1  
SJRWTP TCRA

k:\Jobs\090557-San Jacinto\090557-01 - San Jacinto\090557-01-RP-035.dwg Fig 6 ALT 2 Plan-a  
May 27, 2010 9:57am ghowell



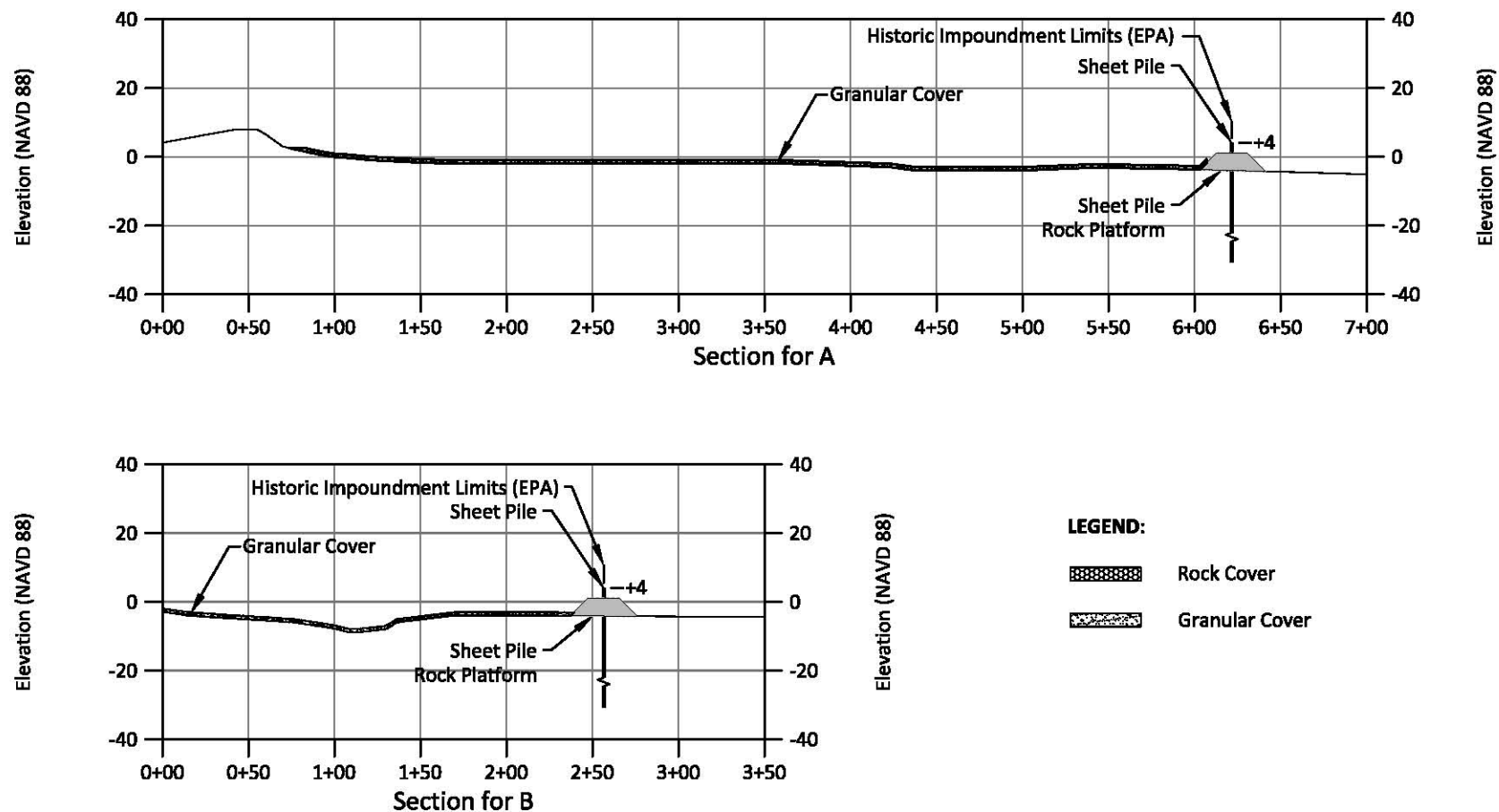
**SOURCE:** Drawing prepared from COE  
**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.  
**VERTICAL DATUM:** NAVD 88.  
**NOTE:** See Figures 7 and 8 for Cross Sections.



Cross Section Locations and Designation



**Figure 6**  
**Alternative 2 Plan View**  
**East Impoundment Sheet Pile, Dredge and Cover**  
**SJRWP TCRA**



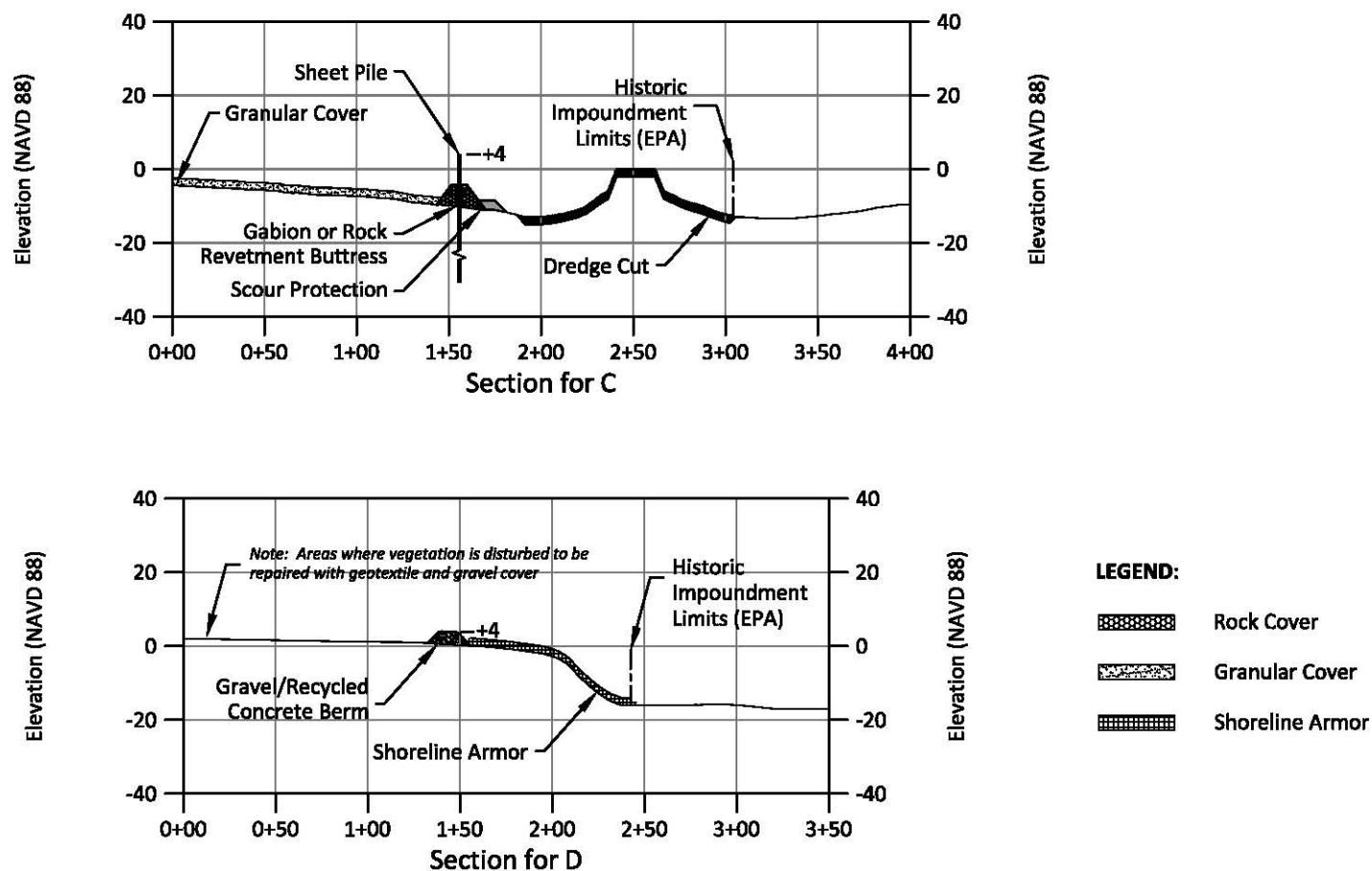
**SOURCE:** Drawing prepared from COE

**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.

**VERTICAL DATUM:** NAVD 88.

**NOTE:** See Figure 6 for Cross Section Locations.

**Figure 7**  
Cross Sections A and B - Alternative 2  
SJRWTP TCRA



**SOURCE:** Drawing prepared from COE

**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.

**VERTICAL DATUM:** NAVD 88.

**NOTE:** See Figure 6 for Cross Section Locations.

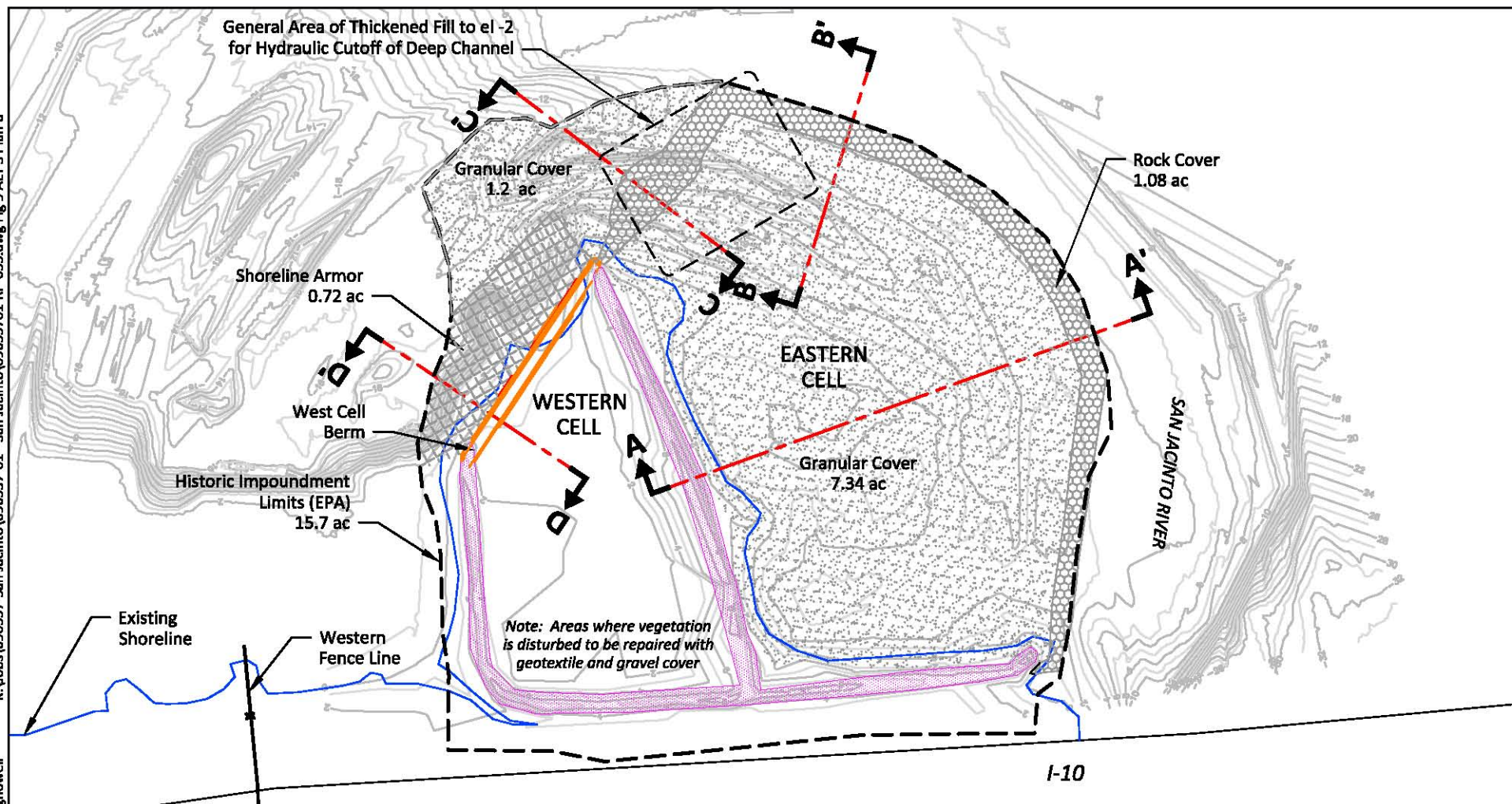
0 100  
Scale in Feet  
Vertical Exaggeration x2



**Figure 8**  
Cross Sections C and D - Alternative 2  
SJRWTP TCRA



k:\jobs\090557-San Jacinto\090557-01 - San Jacinto\09055701-RP-035.dwg Fig 9 ALT 3 Plan-a  
May 27, 2010 9:58am ghowell



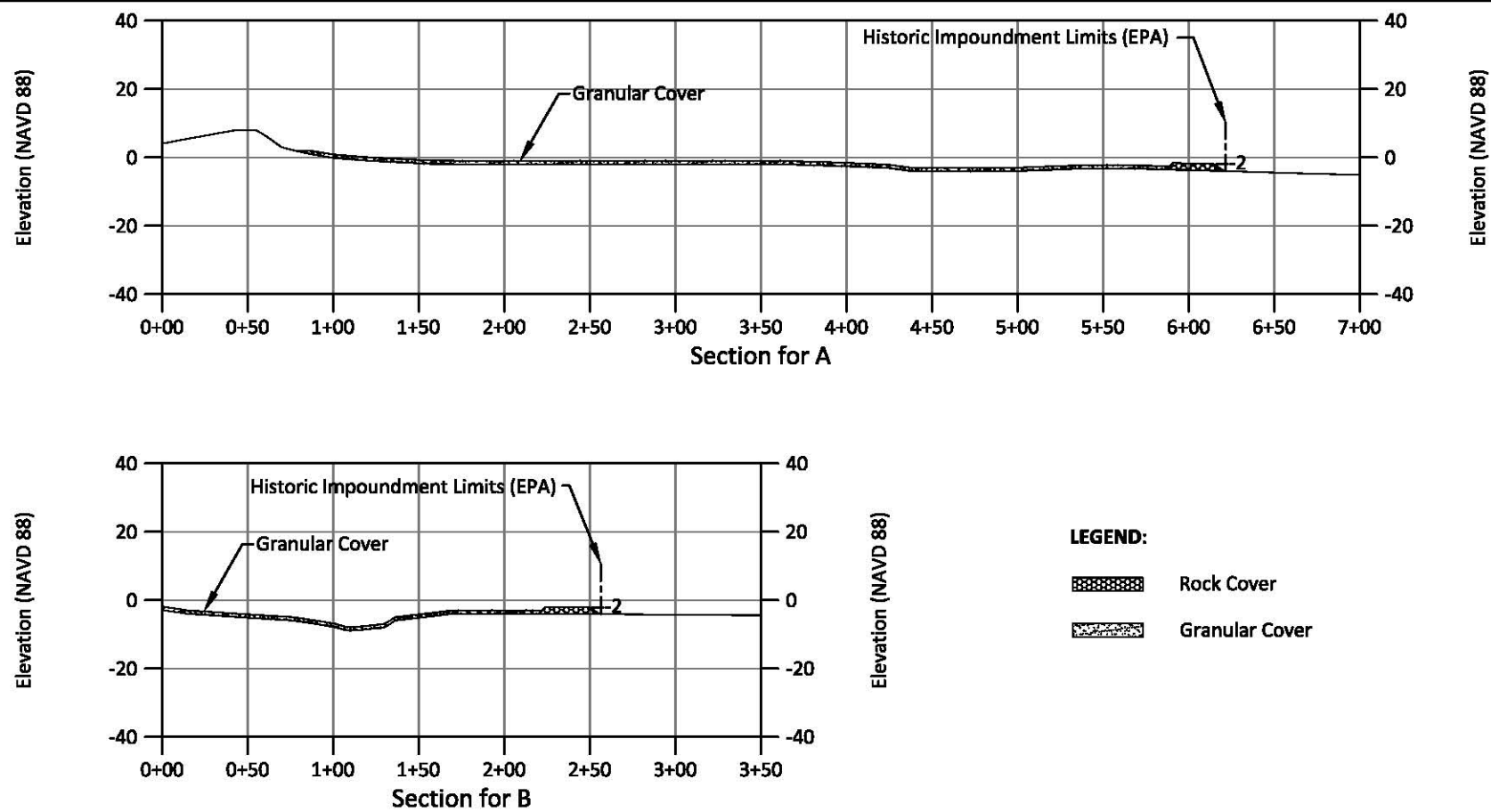
**SOURCE:** Drawing prepared from COE  
**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.  
**VERTICAL DATUM:** NAVD 88.  
**NOTE:** See Figures 10 and 11 for Cross Sections.



Cross Section Locations and Designation



**Figure 9**  
**Alternative 3 Plan View**  
**Sediment Cover**  
**SJRWP TCRA**



**SOURCE:** Drawing prepared from COE

**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.

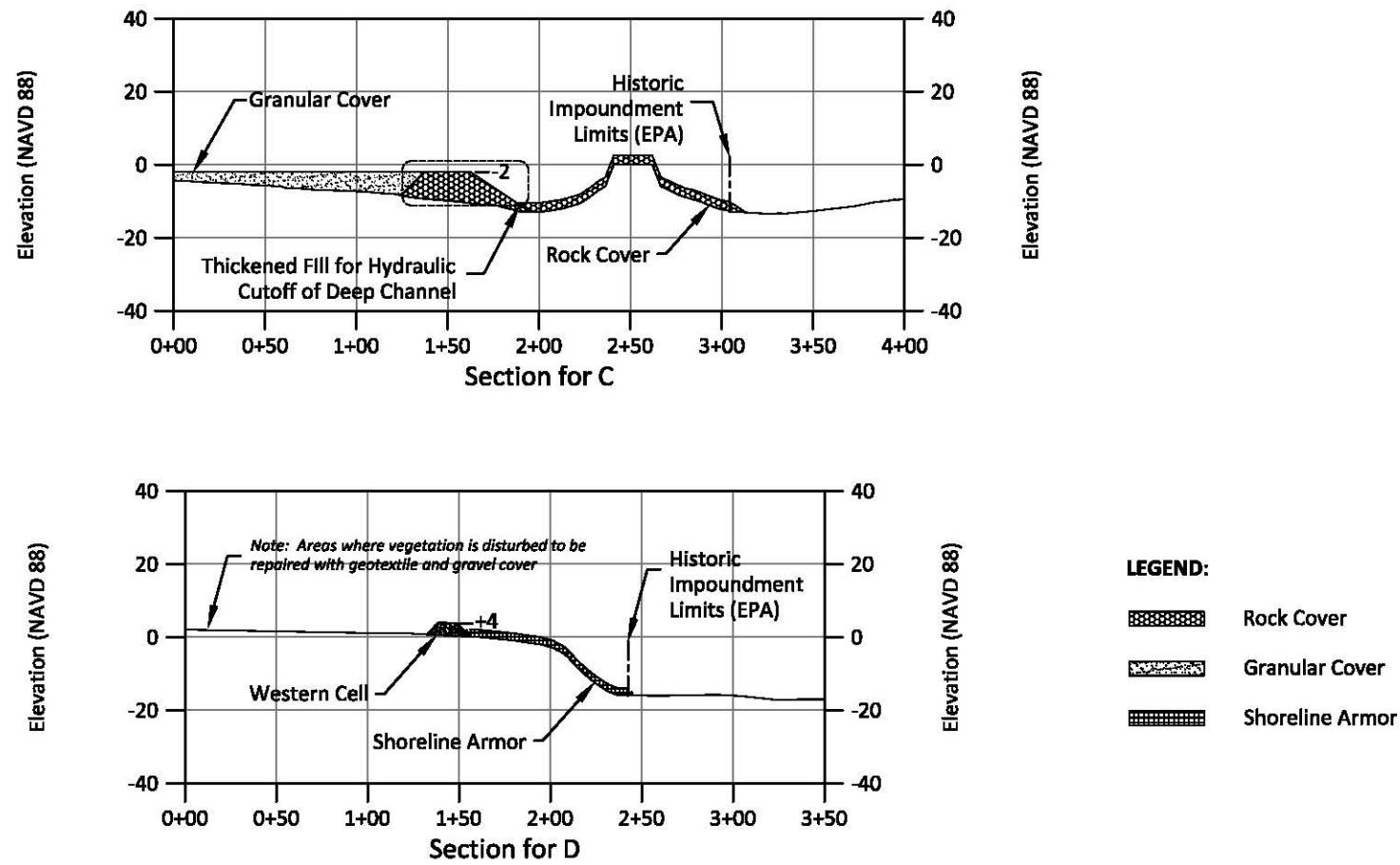
**VERTICAL DATUM:** NAVD 88.

**NOTE:** See Figure 9 for Cross Section Locations.

0 100  
Scale in Feet  
Vertical Exaggeration x2



**Figure 10**  
Cross Sections A and B - Alternative 3  
SJRWTP TCRA



**SOURCE:** Drawing prepared from COE

**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.

**VERTICAL DATUM:** NAVD 88.

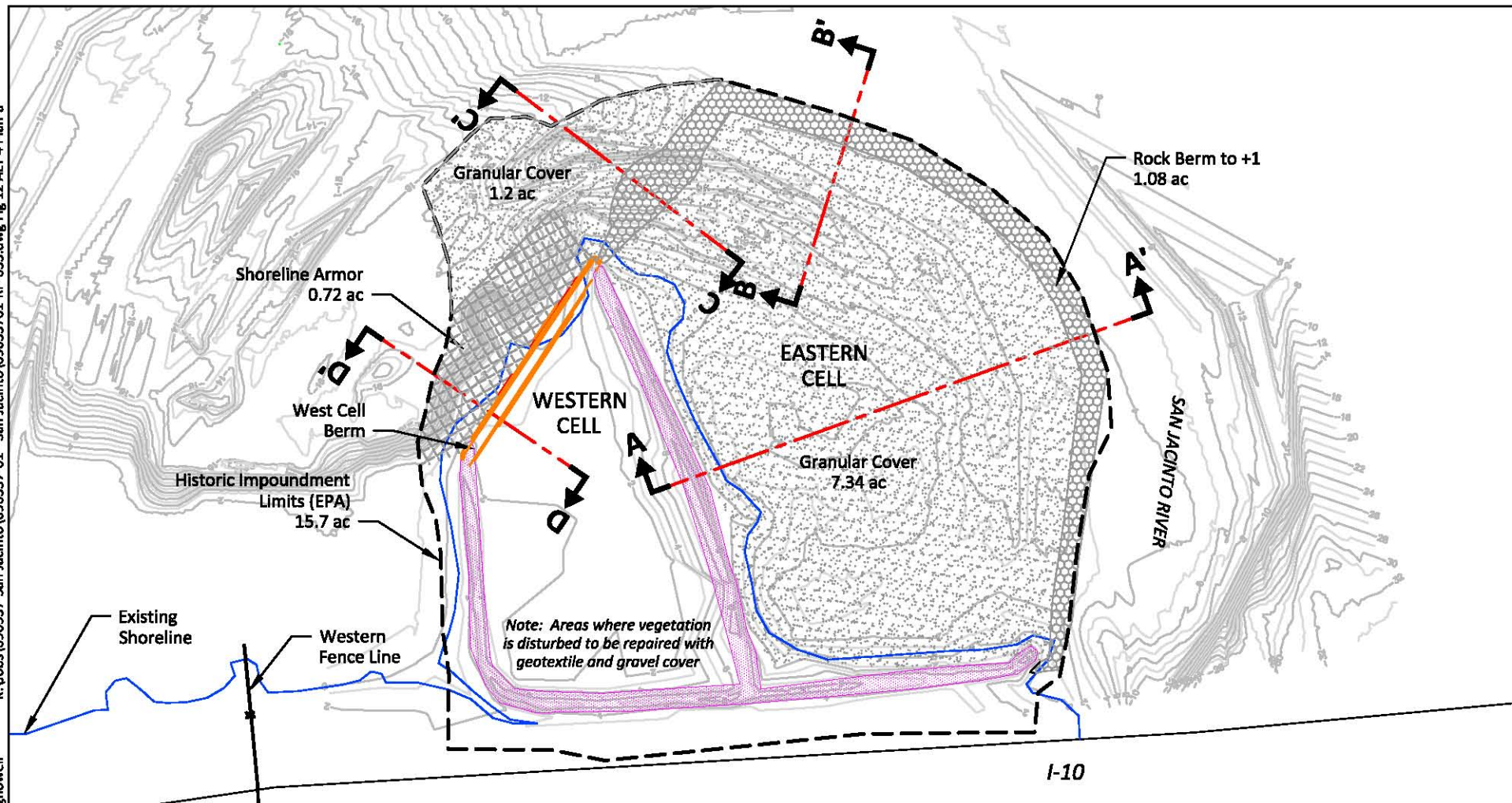
**NOTE:** See Figure 9 for Cross Section Locations.



**Figure 11**  
Cross Sections C and D - Alternative 3  
SJRWTP TCRA



k:\jobs\090557-San Jacinto\090557-01 - San Jacinto\090557-01-RP-035.dwg Fig 12 ALT 4 Plan-a  
May 27, 2010 9:59am ghowell



**SOURCE:** Drawing prepared from COE  
**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.  
**VERTICAL DATUM:** NAVD 88.  
**NOTE:** See Figures 13 and 14 for Cross Sections.

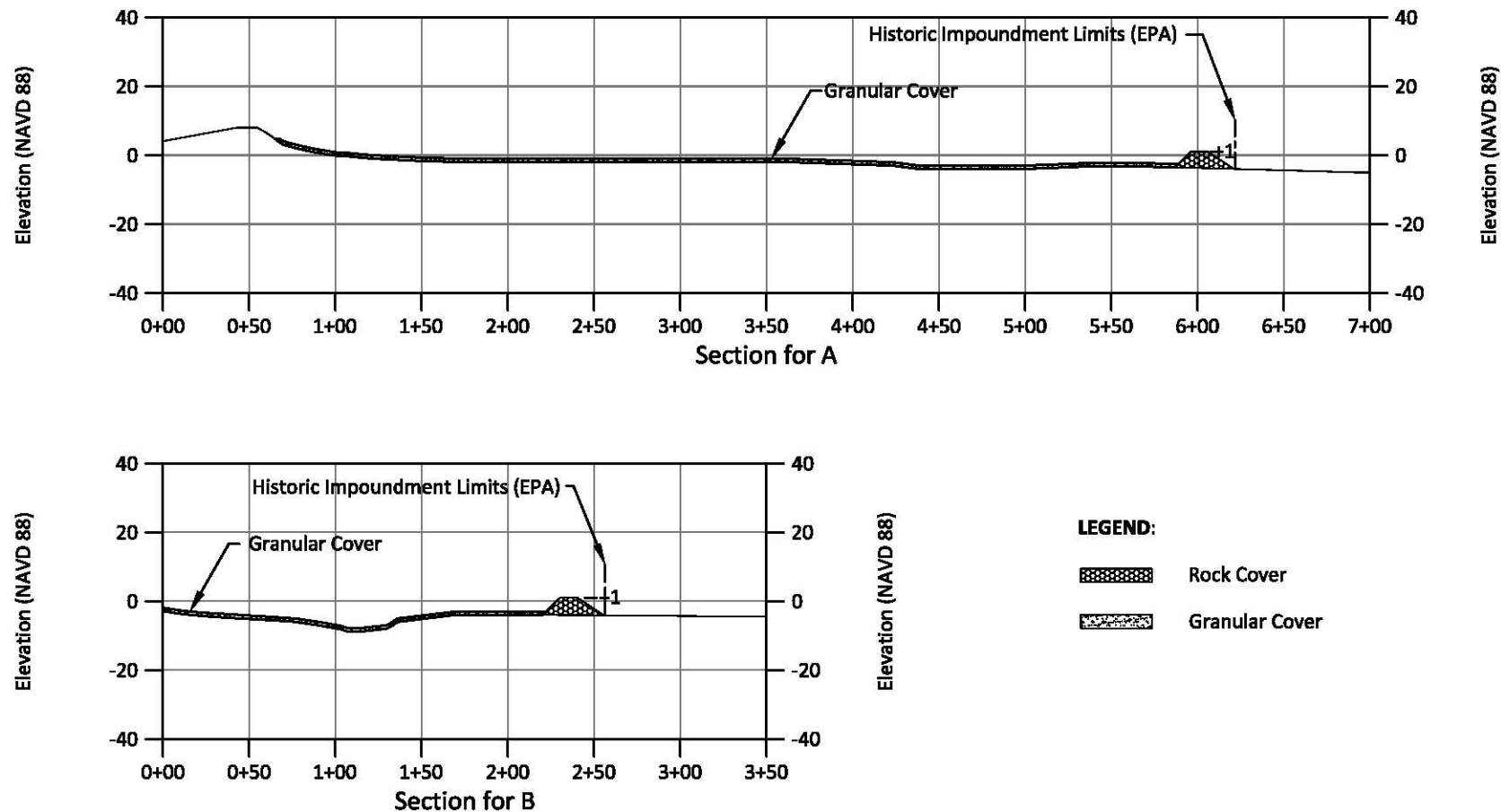


Cross Section Locations and Designation



**Figure 12**  
**Alternative 4 Plan View**  
**East Impoundment Berm and Cover**  
**SJRWP TCRA**





**SOURCE:** Drawing prepared from COE

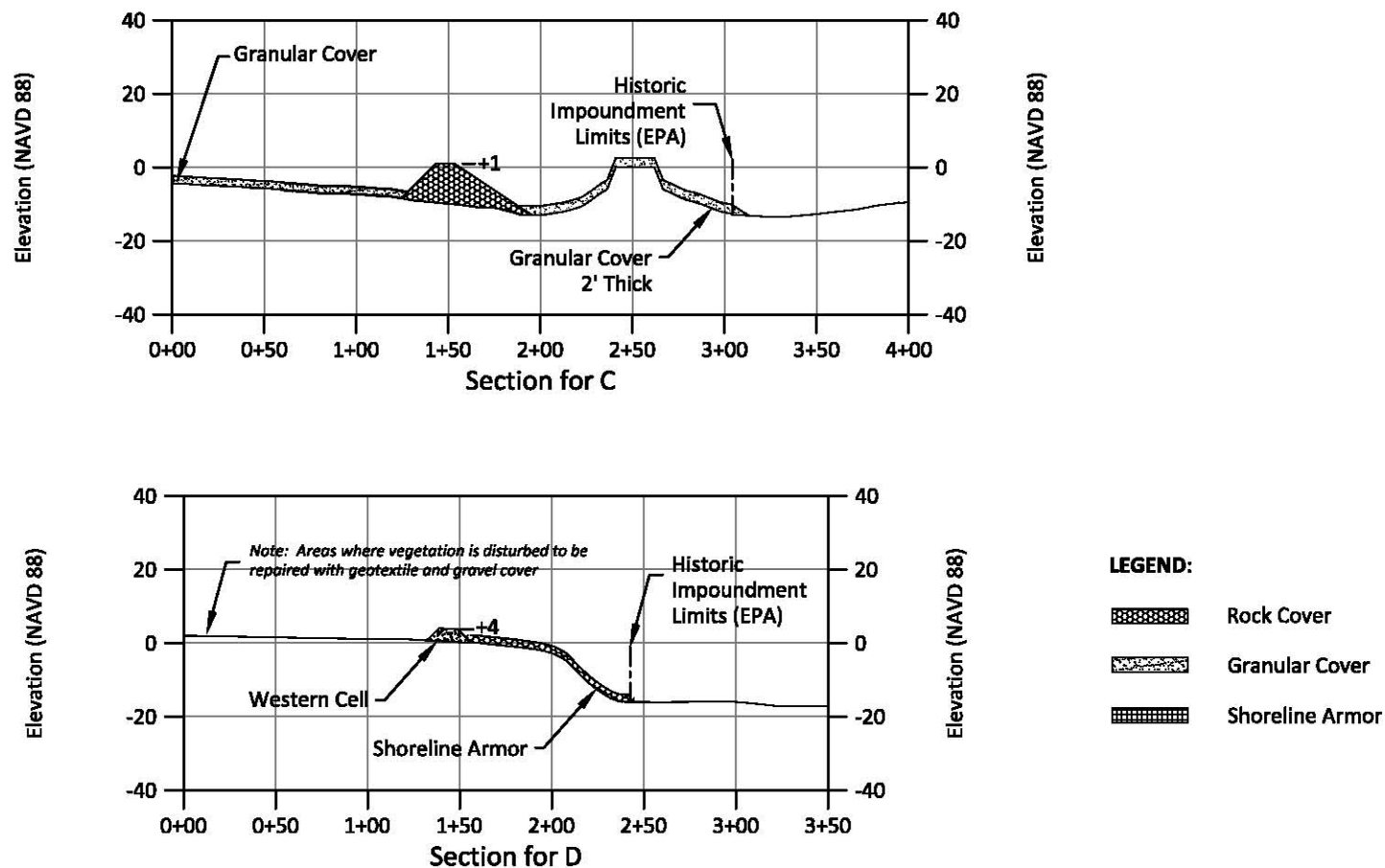
**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.

**VERTICAL DATUM:** NAVD 88.

**NOTE:** See Figure 12 for Cross Section Locations.

0 100  
Scale in Feet  
Vertical Exaggeration x2

**Figure 13**  
Cross Sections A and B - Alternative 4  
SJRWTP TCRA



**SOURCE:** Drawing prepared from COE

**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.

**VERTICAL DATUM:** NAVD 88.

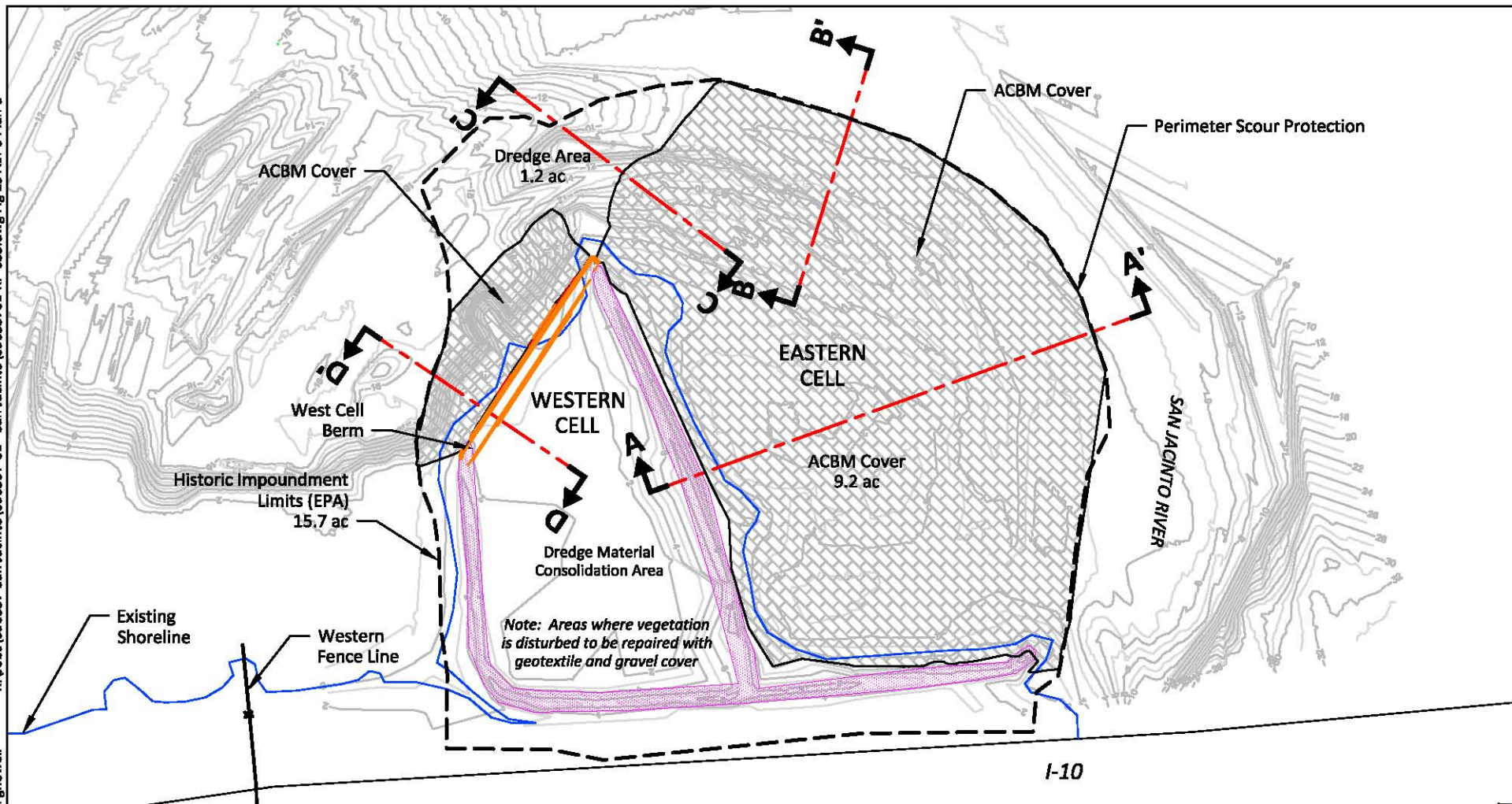
**NOTE:** See Figure 12 for Cross Section Locations.

0 100  
Scale in Feet  
Vertical Exaggeration x2

**Figure 14**  
Cross Sections C and D - Alternative 4  
SJRWTP TCRA



K:\Jobs\090557-San Jacinto\090557-01 - San Jacinto\09055701-RP-035.dwg Fig 15 ALT 5 Plan-a  
 May 27, 2010 10:00am ghowell



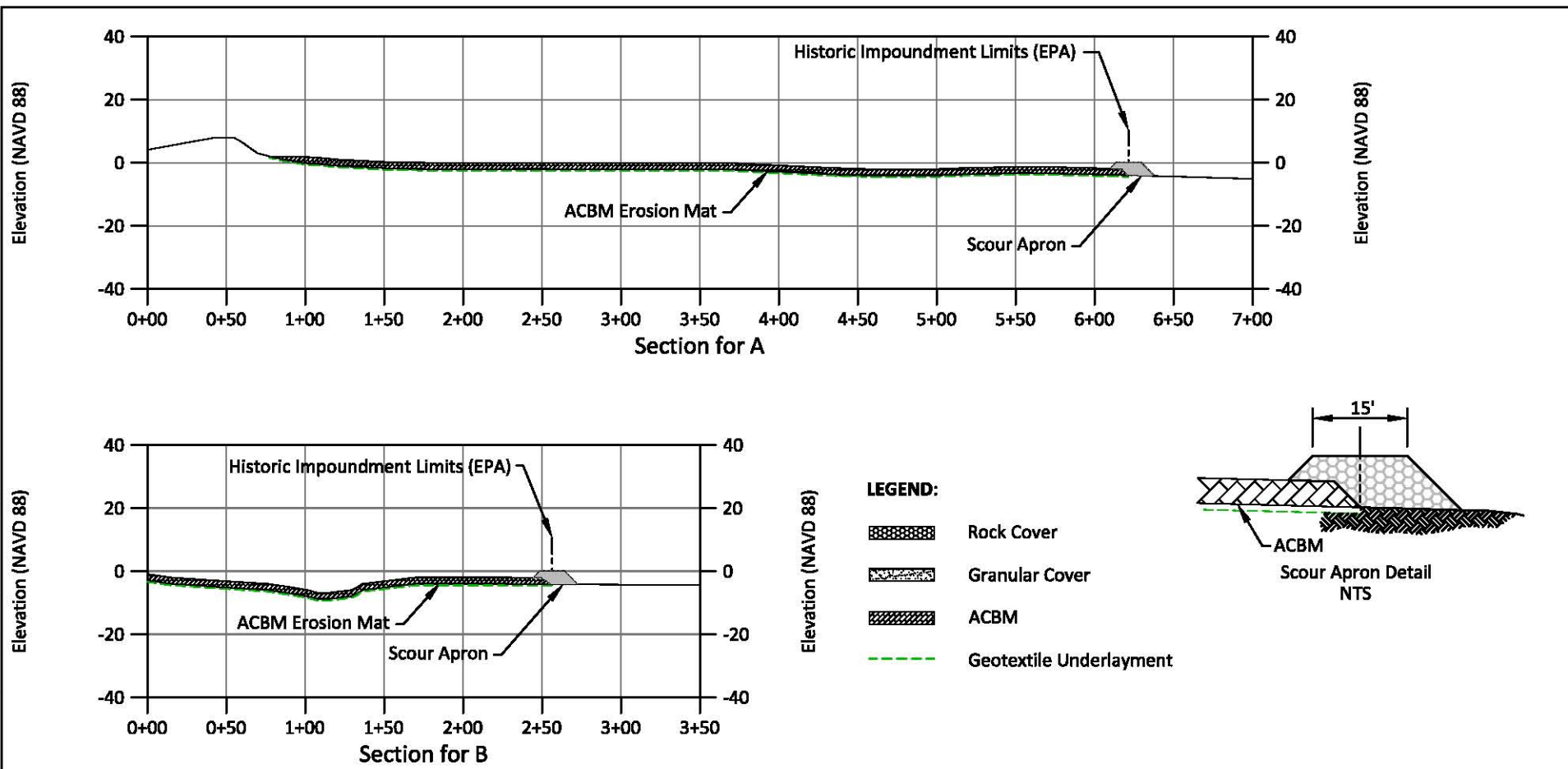
**SOURCE:** Drawing prepared from COE  
**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.  
**VERTICAL DATUM:** NAVD 88.  
**NOTE:** See Figures 16 and 17 for Cross Sections.



Cross Section Locations and Designation

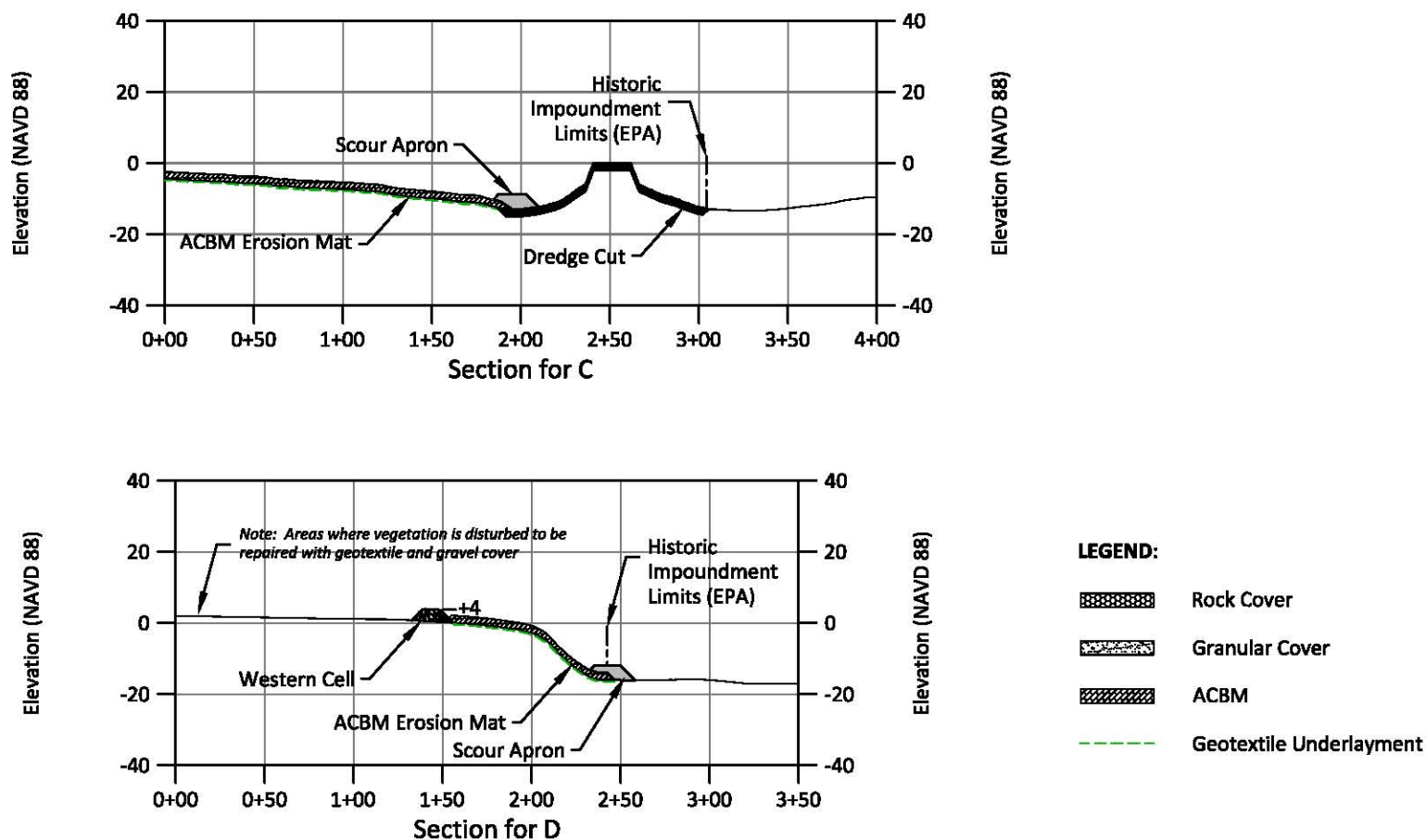


**Figure 15**  
 Alternative 5 Plan View  
 ACBM Stabilization and Dredge  
 SJRWP TCRA



**SOURCE:** Drawing prepared from COE  
**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.  
**VERTICAL DATUM:** NAVD 88.  
**NOTE:** See Figure 15 for Cross Section Locations.

0 100  
 Scale in Feet  
 Vertical Exaggeration x2



**SOURCE:** Drawing prepared from COE

**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.

**VERTICAL DATUM:** NAVD 88.

**NOTE:** See Figure 15 for Cross Section Locations.

0 100  
Scale in Feet  
Vertical Exaggeration x2

**Figure 17**  
Cross Sections C and D - Alternative 5  
SJRWTP TCRA

## APPENDIX A

### DESIGN STORM EVENT MEMORANDUM

---



**MEMORANDUM**

---

**To:** Valmichael Leos, USEPA  
Mike Hasen, HVJ Associates  
Ed Barth, USEPA  
Steve Tzhone, USEPA

**Date:** May 27, 2010

**From:** John Verduin, P.E., Anchor QEA  
John Laplante, P.E., Anchor QEA  
Matt Henderson, P.E., Anchor QEA  
Wendell Mears, Anchor QEA

**Project:** 090557-01

**Cc:** David Keith, Anchor QEA  
Phil Slowiak, International Paper  
Drew Shafer, March Smith, MIMC

**Re:** Design Storm Event: San Jacinto Superfund Site Time Critical Removal Action

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The purpose of this Design Storm Event Memorandum is to define the storm event to be used to design the Time Critical Removal Action (TCRA) for the San Jacinto Superfund Site (Site). The TCRA will be implemented within the next year. Concurrent to the TCRA, International Paper and MIMC (Respondents) are completing a Non-Time Critical Removal Action (NTCRA) Engineering Evaluation/Cost Assessment (EE/CA) to select the appropriate long-term removal action for the Site. The NTCRA is anticipated to be completed within the next two to seven years.

The United States Environmental Protection Agency (USEPA) April 2, 2010, memorandum titled, "Request for a Time Critical Removal Action at the San Jacinto Waste Pits Site, Harris County, Texas" states that the technologies used to control erosion "must be structurally sufficient to withstand forces sustained by the river including any future erosion and be structurally sound for a number of years until a final remedy is designed and implemented. Also, the Houston area is visited by seasonal severe weather events (i.e. strong force winds or flooding) and the physical protective barrier must be structurally secure to withstand any potential future extreme weather events" (USEPA 2010; IV.A.1; Page 9; 3rd paragraph).

---

This memorandum presents the recommended design storm for the TCRA based on a review of guidance documents related to storm events and an analysis of various return-interval storm events in the San Jacinto River.

## **GUIDANCE FOR RESISTANCE TO DESIGN LEVEL STORM EVENTS**

The USEPA and U.S. Army Corps of Engineers (USACE) have developed storm event performance criteria for contaminated sediments sites. For example, USEPA's and USACE's "Guidance for In-Situ Subaqueous Capping of Contaminated Sediments" (Palermo et al. 1998) and USEPA's "Contaminated Sediment Remediation Guidance for Hazardous Waste Sites" (2005) provide guidance for design of technologies to resist design storm events.

"Contaminated Sediment Remediation Guidance for Hazardous Waste Sites" also states that erosion protection features should be "based on the magnitude and probability of occurrence of relatively extreme erosive forces estimated at the capping site. Generally, in-situ caps should be designed to withstand forces with a probability of 0.01 per year, for example, the 100-year storm."

Following USEPA guidance, a permanent remedy would be designed to resist a flow event with a return-period of 100 years. However, the risk of a 100-year storm occurring in the 2- to 7-year time period is only 2 to 6.8 percent. Given the low probability of this occurring, sizing materials to resist this event would be impractical for the short timeframe that the TCRA is expected to be in place. In addition, if a rare, extreme event did occur in the short timeframe, the disruption to the cover system could be easily observed and repaired as necessary. Therefore, an evaluation was performed to determine an equivalent storm event for a shorter design life span shorter than the typical 100-year design.

## **ANALYSIS OF STORM DATA RETURN PERIODS**

As previously discussed, the anticipated design and construction period for the NTCRA is two to seven years, which is the anticipated range of wait time between the completion of TCRA construction and the implementation of the final NTCRA. This period could be shorter or longer depending on uncontrollable events. The purpose of this analysis is to determine the likelihood that the TCRA remedy would experience a flow event greater than the intended design life.

---

Table 1 presents the probability of occurrence of 2-, 5-, 10-, and 25-year storm events to occur within the two and seven year period). As an example from Table 1, a 5-year flow event has an annual probability of occurring in any given year of 20 percent. The 5-year event would have a 36 percent chance of occurring during a 2-year wait period and a 79 percent chance during a 7-year wait period.

**Table 1**  
**Percent Chance of Occurrence**

| Return Period<br>(years) | Annual Percent Chance of<br>Occurrence (percent) | Period of Concern (years) |    |
|--------------------------|--|---------------------------|----|
|                          |  | 2                         | 7  |
| 2                        | 50   | 75                        | 99 |
| 5                        | 20   | 36                        | 79 |
| 10                       | 10   | 19                        | 52 |
| 25                       | 4  | 8                         | 25 |

As previously discussed, USEPA guidance recommends designing permanent engineered caps for a 100-year flow event. Over a 100-year design life, the percent chance of a 100-year flow event occurring is approximately 63 percent.

As described in the USEPA guidance, the design life for most civil works projects such as bridges or dams is approximately 50 years (Palermo et al. 1998). The probability of a 100-year event occurring in 50-year design life is approximately 40 percent. In addition, in the USACE's "Hydraulic Design for Local Flood Protection Projects", the USACE recommends that "...all channel elements will perform satisfactorily for flows up to and including the annual flood frequency which has a 50 percent probability of being exceeded during the project economic life." A 2-year event has a 50 percent probability of occurrence on an annual basis. For a 7-year design life, the flood event that has a 50 percent probability of occurring is the 10-year event.

For a temporary two- to seven- year TCRA, a flow event with an equivalent chance of occurring during a two to seven year period of approximately 63 percent would correspond to a 2- to 10-year storm event. Therefore, the TCRA will be designed to resist 10-year return-interval flow events in the San Jacinto River consistent with the USEPA and USACE guidance.

## REFERENCES

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- Palermo, M., S. Maynard, J. Miller, and D. Reible. 1998. "Guidance for In-Situ Subaqueous Capping of Contaminated Sediments." EPA 905-B96-004, Great Lakes National Program Office, Chicago, IL.
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- USEPA. 2010. Memorandum titled, "Request for a Time Critical Removal Action at the San Jacinto Waste Pits Site, Harris County, Texas." From V. Leos to S. Coleman, P.E. April 2, 2010.
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APPENDIX B  
HYDRODYNAMIC MODELING  
MEMORANDUM

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## MEMORANDUM

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**To:** Valmichael Leos, USEPA  
Mike Hasen, HVJ Associates  
Ed Barth, USEPA  
Steve Tzhone, USEPA

**Date:** May 27, 2010

**From:** Matt Henderson, PE, Anchor QEA  
John Verduin, PE, Anchor QEA  
Wendell Mears, Anchor QEA  
John Laplante, PE, Anchor QEA

**Project:** 090557-01

**Cc:** David Keith, Anchor QEA  
Phil Slowiak, International Paper  
Drew Shafer, March Smith, MIMC

**Re:** San Jacinto Superfund Site Time Critical Removal Action  
Methodology for Evaluating Cover Material Sizes

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At the May 12, 2010, San Jacinto Superfund Site (Site) Time Critical Removal Action (TCRA) alternatives evaluation meeting between the Respondents and the U.S. Environmental Protection Agency (USEPA) in Houston, Texas, USEPA requested information on the methodology used to evaluate the required size of armor materials needed to resist erosion. This memorandum summarizes the methodology that is being used to assess the size of the TCRA cover materials for the Site.

The USEPA April 2, 2010, memorandum titled, "Request for a Time Critical Removal Action at the San Jacinto Waste Pits Site, Harris County, Texas" states that the technologies used to control erosion "must be structurally sufficient to withstand forces sustained by the river including any future erosion and be structurally sound for a number of years until a final remedy is designed and implemented. Also, the Houston area is visited by seasonal severe weather events (i.e. strong force winds or flooding) and the physical protective barrier must be structurally secure to withstand any potential future extreme weather events" (USEPA 2010; IV.A.1; Page 9; 3rd paragraph).

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Below, we discussed the methodology followed for evaluating the cover material, describe the hydrodynamic model, discuss the process used to determine the stable grain size given the hydrodynamic forces, and conclude with what will be done as part of final design.

## **METHODOLOGY FOR EVALUATING COVER MATERIAL**

The primary objective of the cover material is to prevent exposure and erosion of the materials located on the Site while the non-TCRA is being designed and implemented. The cover material is being designed using methods developed by the USEPA and the U.S. Army Corps of Engineers (USACE) and presented in “Armor Layer Design of Guidance for In-Situ Subaqueous Capping of Contaminated Sediments” (Maynard 1998).

As described above, high flows resulting from rainfall runoff and storm surges can occur in the San Jacinto River. These high flows can result in elevated velocities (and associated bed shear stress) at the Site and have the potential to erode and/or resuspend the materials at the Site. To evaluate the velocities and shear stresses at the Site for various return-interval flow events, a hydrodynamic model was developed. This model was used to compute velocities, water depths, and bed shear stresses at the Site under various flow conditions. Results were used to compute representative particle sizes (diameters) that will resist erosion associated with current velocities using the methods presented in Maynard (1998).

## **HYDRODYNAMIC MODEL DESCRIPTION**

As described above, a hydrodynamic model was developed to simulate flow in the lower San Jacinto River at the Site and nearby regions. The model being used is the Environmental Fluid Dynamics Code (EFDC), which is supported by the USEPA. EFDC is a general purpose hydrodynamic model capable of simulating flow in rivers, lakes, reservoirs, estuaries, and coastal oceans. The EFDC hydrodynamic model of the lower San Jacinto River basin is a two-dimensional, depth-averaged model and predicts flow velocity, water depth, and shear stress. The EFDC model for the lower San Jacinto River was initially developed to evaluate flow and sediment transport patterns in the San Jacinto River to support the sampling plan design for the non-TCRA chemical fate and transport modeling study. The model was subsequently refined for use in evaluating flow velocities at the Site. Details of the model development are briefly summarized below.

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The following information is needed to develop the hydrodynamic model:

1. Bathymetry of the San Jacinto River and topography of the floodplain in the vicinity of the Site
2. Flow at the upstream model boundary
3. Tidal elevations at the downstream boundary

The model domain consists of orthogonal grid cells, extending from the confluence of the San Jacinto River and the Houston Ship Channel to approximately 7 river miles upstream. The model grid cell size is 100-foot by 100-foot in the areas farthest from the Site and is refined to 50-foot by 50-foot at the Site. The model consists of 32,361 elements. The model bathymetry was estimated by interpolating National Oceanic and Atmospheric Administration (NOAA) point bathymetry measurements, supplemented by the bathymetry collected in the immediate area of the Site in February 2009. Floodplain topography in the vicinity of the Site was estimated from the U.S. Geological Survey (USGS) Digital Elevation Model (DEM).

Fifteen-day simulations were conducted at constant flow rates equal to the 5-, 10-, and 25-year flow. Inflow at the upstream boundary was estimated using daily average flows measured at six upstream USGS gauging stations. The daily flows were summed and prorated by the ratio of the drainage area at the Lake Houston Dam to the combined drainage area of the six upstream stations. The Lake Houston is a water supply reservoir. Water supply reservoirs attempt to maintain water levels as high as possible to assure the largest water supply in times of drought. These reservoirs do not provide significant storage during flood events (Harris County Flood Control District 2010). A flood frequency analysis was performed on the adjusted flows to estimate the 5-, 10-, and 25-year flow rates. Stage height measured at the NOAA tidal station at Battleship Texas State Park, Texas from September 1 to 15, 2005, was used as the downstream boundary condition. Upper and lower-bound sensitivity analyses were performed by increasing the stage height by the difference between mean sea level and mean higher high water, and decreasing the stage height by the difference between mean sea level and mean lower low water. In addition, Hurricane Ike (which impacted the area in September 2008) was also simulated with the hydrodynamic model. Measurements of flow at the Lake Houston Dam during the event were used as the inflow boundary condition for the model simulation. The nearest NOAA tidal station with

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continuous stage height data during the event is Eagle Point, Texas. A relationship was found between long-term (1993 to 2009) data collected at the Eagle Point, Texas station and the Morgans Point, Texas station. This relationship was used to predict the storm surge at the downstream boundary during the event.

## STABLE PARTICLE SIZE TO RESIST CURRENT VELOCITIES

The method presented in Maynard (1998) is based on the USACE's "Hydraulic Design of Flood Control Channels" (USACE 1994). This method uses velocity and flow depth computed by the depth-averaged hydrodynamic model to determine the size of the cover material.

Equation 2 from Maynard (1998) is

$$D_{50} = S_f C_s C_v C_T C_G d \left[ \left( \frac{\gamma_w}{\gamma_s - \gamma_w} \right)^{\frac{1}{2}} \frac{V}{\sqrt{K_1 g d}} \right]^{2.5}$$

where:

- $D_{50}$  = median particle size in feet
- $S_f$  = safety factor
- $C_s$  = stability coefficient for incipient failure
- $C_v$  = velocity distribution coefficient
- $C_T$  = blanket thickness coefficient
- $C_G$  = gradation coefficient =  $(D_{85}/D_{15})^{1/3}$
- $D_{85}/D_{15}$  = gradation uniformity coefficient
- $d$  = water depth in feet
- $\gamma_s$  = unit weight of stone
- $\gamma_w$  = unit weight of water
- $V$  = maximum depth-averaged velocity in feet per second
- $K_1$  = side slope correction factor
- $g$  = acceleration due to gravity

Stable particle sizes were computed for the Site for each alternative using the equation above. The need for filter layer between the stable particles sizes and the materials at the Site considering Site conditions and design life will be evaluated as part of the design.

## CONCLUSION

A hydrodynamic model has been developed to assess the flow velocities and water depths at the Site under various flow events in the lower San Jacinto River. Stable particles sizes to cover the Site and resist the forces from various flow events for the different alternatives were computed using the hydrodynamic model results and USEPA design guidance. As part of final design the hydrodynamic model and stable particle size for the selected alternative will be refined. The final gradation and filter requirements will be submitted as part of the TCRA Work Plan that includes the final design package.

## REFERENCES

- Harris County Flood Control District. 2010. San Jacinto Watershed Website.  
[http://www.hcfcd.org/l\\_sanjacriver.html](http://www.hcfcd.org/l_sanjacriver.html). Accessed on May 27, 2010.
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# APPENDIX C

## COST ESTIMATE DETAIL

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**SAN JACINTO RIVER WASTE PIT - TIME CRITICAL REMEDIAL ACTION  
COST ESTIMATE SUMMARY TABLE**

| <u>TCRA ALTERNATIVE</u>  | <u>COST (\$M)</u> |
|--|-------------------|
| <b>Alternative 1:</b> Rock Platform to Support Land-Based Installation Operations, Vinyl Sheet Pile Wall with Scour Protection to Historic Impound Limits along entire Site, Granular Cover to Elevation -1 Inside Wall  | <b>\$5.84</b>     |
| <b>Alternative 2:</b> Rock Platform to Support Land-Based Installation Operations, Eastern Cell Vinyl Sheet Pile Wall with Scour Protection to Historic Impound Limits, Granular Cover to Elevation -1 Inside Wall, Western Cell Control Berm and Shoreline Armoring, Dredging to Geobags in Northwestern Area | <b>\$5.08</b>     |
| <b>Alternative 3:</b> Granular Cover over Eastern Cell, Eastern Cell Clay Cover and Rock Cover Layers, Western Cell Control Berm, Granular Cover in Northwestern Area  | <b>\$3.56</b>     |
| <b>Alternative 4:</b> Granular Cover over Eastern Cell, Eastern Cell Earth Berm and Rock Berm to Elevation +1, Western Cell Control Berm and Shoreline Armoring, Granular Cover in Northwestern Area   | <b>\$4.02</b>     |
| <b>Alternative 5:</b> Western Cell Control Berm, ACBM Cover over entire Eastern Cell and Shoreline of Western Cell, Dredging to Geobags in Northwestern Area   | <b>\$6.94</b>     |

|   | Alternative 1   | Alternative 2   | Alternative 3 | Alternative 4 | Alternative 5 |
|---|-----------------|-----------------|---------------|---------------|---------------|
| ITEM  | Full Sheet Pile | East Sheet Pile | - 2 Cover     | + 1 Berm      | ACBM          |
| <b>Mobilization and Site Preparation</b>        |                 |                 |               |               |               |
| Mobilization/Demobilization                     | \$ 325,000      | \$ 390,000      | \$ 250,000    | \$ 280,000    | \$ 575,000    |
| Health and Safety                               | \$ 69,000       | \$ 56,000       | \$ 32,000     | \$ 31,000     | \$ 31,000     |
| Quality Control                                 | \$ 69,000       | \$ 56,000       | \$ 32,000     | \$ 31,000     | \$ 31,000     |
| Access Road Construction                        | \$ 80,000       | \$ 80,000       | \$ 80,000     | \$ 80,000     | \$ 80,000     |
| Environmental Controls                          | \$ 172,000      | \$ 172,000      | \$ 172,000    | \$ 172,000    | \$ 172,000    |
|   |                 |                 |               |               |               |
| <b>Survey</b>                                   |                 |                 |               |               |               |
| Survey Control and Material Placement Surveys   | \$ 12,000       | \$ 8,000        | \$ 12,000     | \$ 12,000     | \$ 12,000     |
|   |                 |                 |               |               |               |
| <b>Sheet Pile</b>                               |                 |                 |               |               |               |
| Rock Platform                                   | \$ 446,000      | \$ 409,000      | \$ -          | \$ -          | \$ -          |
| Steel Sheetpile Wall Construction               | \$ 1,380,000    | \$ 822,000      | \$ -          | \$ -          | \$ -          |
| Sheet Pile Buttress and Scour Protection        | \$ 495,000      | \$ 199,000      | \$ -          | \$ -          | \$ -          |
|   |                 |                 |               |               |               |
| <b>Cover and Shoreline Protection</b>           |                 |                 |               |               |               |
| <b>Eastern Cell</b>                             |                 |                 |               |               |               |
| Eastern Cell Granular Cover                     | \$ 783,000      | \$ 630,000      | \$ 725,000    | \$ 656,000    | \$ -          |
| Eastern Cell Rock Cover/Berm                    | \$ -            | \$ -            | \$ 490,000    | \$ 857,000    | \$ -          |
| Eastern Cell Geotextile - Rock                  | \$ -            | \$ -            | \$ 29,000     | \$ 32,000     | \$ -          |
| Eastern Cell ACBM Cover                         | \$ -            | \$ -            | \$ -          | \$ -          | \$ 2,956,000  |
| <b>Western Cell</b>                             |                 |                 |               |               |               |
| Western Cell Geotextile - Granular Cover        | \$ 27,000       | \$ -            | \$ -          | \$ -          | \$ -          |
| Western Cell Granular Cover                     | \$ 34,000       | \$ -            | \$ -          | \$ -          | \$ -          |
| Western Cell Geotextile - Shoreline Armoring    | \$ -            | \$ 20,000       | \$ 20,000     | \$ 20,000     | \$ -          |
| Western Cell Rock Shoreline Armoring            | \$ -            | \$ 320,000      | \$ 320,000    | \$ 320,000    | \$ -          |
| Western Cell ACBM Shoreline Armoring            | \$ -            | \$ -            | \$ -          | \$ -          | \$ 252,000    |
| Western Cell Rock Protection                    | \$ 28,000       | \$ -            | \$ -          | \$ -          | \$ -          |
| Western Cell Berm                               | \$ -            | \$ 51,000       | \$ 51,000     | \$ 51,000     | \$ 51,000     |
| Western Cell Vegetation Repair - Geotextile     | \$ 11,000       | \$ 11,000       | \$ 11,000     | \$ 11,000     | \$ 11,000     |
| Western Cell Vegetation Repair - Granular Cover | \$ 23,000       | \$ 23,000       | \$ 23,000     | \$ 23,000     | \$ 23,000     |
| <b>Northwestern Area</b>                        |                 |                 |               |               |               |
| Northwestern Area Granular Cover                | \$ -            | \$ -            | \$ 96,000     | \$ 96,000     | \$ -          |
| ACBM Perimeter Protection                       | \$ -            | \$ -            | \$ -          | \$ -          | \$ 357,000    |
|   |                 |                 |               |               |               |
| <b>Dredging and Dewatering</b>                  |                 |                 |               |               |               |
| Northwestern Area Hydraulic Dredging            | \$ -            | \$ 33,000       | \$ -          | \$ -          | \$ 33,000     |
| Geobag Dewatering                               |                 |                 |               |               |               |
| Geotextile Layer                                | \$ -            | \$ 25,000       | \$ -          | \$ -          | \$ 25,000     |
| Bedding Layer                                   | \$ -            | \$ 10,000       | \$ -          | \$ -          | \$ 10,000     |
| Purchase and Setup Bags                         | \$ -            | \$ 99,000       | \$ -          | \$ -          | \$ 99,000     |
| Maintenance                                     | \$ -            | \$ 12,000       | \$ -          | \$ -          | \$ 12,000     |
|   |                 |                 |               |               |               |
| <b>Total Construction Cost</b>                  | \$ 3,954,000    | \$ 3,426,000    | \$ 2,343,000  | \$ 2,672,000  | \$ 4,730,000  |
| <b>Contingency</b>                              | \$ 1,187,000    | \$ 1,028,000    | \$ 703,000    | \$ 802,000    | \$ 1,419,000  |
|   |                 |                 |               |               |               |
| <b>Non-Construction Costs</b>                   |                 |                 |               |               |               |
| Engineering Design                              | \$ 100,000      | \$ 100,000      | \$ 100,000    | \$ 100,000    | \$ 100,000    |
| Construction Management                         | \$ 317,000      | \$ 274,000      | \$ 188,000    | \$ 214,000    | \$ 379,000    |
| Close Out & Documentation                       | \$ 20,000       | \$ 17,000       | \$ 12,000     | \$ 14,000     | \$ 24,000     |
| Regulatory Compliance Documentation             | \$ 45,000       | \$ 45,000       | \$ 45,000     | \$ 45,000     | \$ 45,000     |
| Environmental Monitoring during Construction    | \$ 152,000      | \$ 123,000      | \$ 68,000     | \$ 66,000     | \$ 65,000     |
| OM & M  | \$ 61,000       | \$ 68,000       | \$ 97,000     | \$ 110,000    | \$ 181,000    |
|   |                 |                 |               |               |               |
| <b>Total Non-Construction Cost</b>              | \$ 1,882,000    | \$ 1,655,000    | \$ 1,213,000  | \$ 1,351,000  | \$ 2,213,000  |
|   |                 |                 |               |               |               |
| <b>TOTAL COST</b>                               | \$ 5,836,000    | \$ 5,081,000    | \$ 3,556,000  | \$ 4,023,000  | \$ 6,943,000  |



**SAN JACINTO RIVER WASTE PIT - TIME CRITICAL REMEDIAL ACTION**  
**COST ESTIMATE TABLE**

Alternative 1: Rock Platform Construction, Composite Sheet Pile Wall at Historic Impound Limits along entire Site, Targeted Scour Protection, Granular Cover over Eastern and Western Cells

| Item No.                                     | Description                                   | Estimated Quantity | Unit  | Unit Price | Estimated Amount    | Notes   |
|--|---|--------------------|-------|------------|---------------------|---|
| <b>Project Set Up</b>                        |   |                    |       |            |                     |   |
| 1  | Mobilization/Demobilization                   | 1                  | LS    | \$ 325,000 | \$ 325,000          | Includes sheet pile mob/demob costs   |
|  | Health & Safety                               | 1                  | LS    | \$ 69,000  | \$ 69,000           | Planning, staffing and implementation   |
|  | Quality Control                               | 1                  | LS    | \$ 69,000  | \$ 69,000           | Planning, staffing and implementation   |
| 2  | Environmental Controls                        | 1                  | LS    | \$ 172,000 | \$ 172,000          | Maritime signage/fishing advisory markers, reinforced wire fencing, access gates, silt fencing, turbidity curtain                     |
| 3  | Access Road Construction                      | 1                  | LS    | \$ 80,000  | \$ 80,000           |   |
| 4  | Survey Control and Material Placement Surveys | 3                  | EA.   | \$ 4,000   | \$ 12,000           |   |
| <b>Site Protection</b>                       |   |                    |       |            |                     |   |
| 5  | Rock Platform                                 | 15,900             | TONS  | \$ 28.00   | \$ 446,000          | 18-foot wide rock platform for land-based sheetpile wall installation   |
| 6  | Sheetpile Wall Construction                   | 86,250             | SF    | \$ 16.00   | \$ 1,380,000        | Vinyl sheetpile wall to be installed at the Historic Impoundment Limits with water depths reaching 16-feet up to elevation +4 NAVD 88 |
| 7  | Rock Buttress and Scour Protection            |                    |       |            |                     |   |
|  | Inner Wall Protection                         | 5,100              | TONS  | \$ 29.00   | \$ 148,000          | Assumes bull rock 12-ft high inside wall at 1.5H:1V slope   |
|  | Outer Wall Protection                         | 4,950              | TONS  | \$ 70.00   | \$ 347,000          | Assumes large limestone rock 12-ft high inside wall at 1.5H:1V slope  |
| <b>Eastern Cell Protection</b>               |   |                    |       |            |                     |   |
| 8  | Eastern Cell Granular Cover                   | 27,000             | TONS  | \$ 29.00   | \$ 783,000          | 10.44 acres, 0.5-ft cover and 0.5-ft overplacement  |
| <b>Western Cell Protection</b>               |   |                    |       |            |                     |   |
| 9  | Western Cell Cover                            |                    |       |            |                     |   |
|  | Rock Protection                               | 990                | TONS  | \$ 28.00   | \$ 28,000           | 40-Foot wide rock protection at top-of-slope  |
|  | Granular Cover                                | 1,300              | TONS  | \$ 26.00   | \$ 34,000           | 6-Inch layer of granular cover over slope   |
|  | Geotextile                                    | 5,350              | SQ YD | \$ 5.00    | \$ 27,000           | Placed beneath granular cover on slope  |
|  | Vegetated Area Repair - Geotextile            | 2,670              | SQ YD | \$ 4.00    | \$ 11,000           | Geotextile and granular cover over vegetated areas disturbed by operations  |
|  | Vegetated Area Repair - Granular Cover        | 790                | TONS  | \$ 29.00   | \$ 23,000           | Geotextile and granular cover over vegetated areas disturbed by operations  |
| <b>Direct Construction Costs Subtotal</b>    |   |                    |       |            | <b>\$ 3,954,000</b> |   |
| <b>Non-Construction Costs</b>                |   |                    |       |            |                     |   |
| 10   | Contingency                                   |                    |       | 30%        | \$ 1,187,000        |   |
| 11   | Engineering Design                            | 1                  | LS    | \$ 100,000 | \$ 100,000          |   |
| 12   | Construction Management                       |                    |       | 8%         | \$ 317,000          |   |
| 13   | Close Out & Documentation                     |                    |       | 0.50%      | \$ 20,000           |   |
| 14   | Regulatory Compliance Documentation           | 1                  | LS    | \$ 45,000  | \$ 45,000           |   |
| 15   | Environmental Monitoring                      | 6.1                | MO    | \$ 25,000  | \$ 152,000          |   |
| 16   | OM & M  | 1                  | LS    | \$ 61,000  | \$ 61,000           |   |
| <b>In-Direct Construction Costs Subtotal</b> |   |                    |       |            | <b>\$ 1,882,000</b> |   |
| <b>Total Option Costs</b>                    |   |                    |       |            | <b>\$ 5,836,000</b> |   |

**SAN JACINTO RIVER WASTE PIT - TIME CRITICAL REMEDIAL ACTION  
COST ESTIMATE TABLE**

Alternative 1: Rock Platform Construction, Composite Sheet Pile Wall at Historic Impound Limits along entire Site, Targeted Scour Protection, Granular Cover over Eastern and Western Cells

General Comments:

- This alternative includes the operations to complete the recommended Time Critical Remedial Action (TCRA). A vinyl sheetpile wall will be constructed around the perimeter of the cell. The wall will be driven through a rock platform constructed in the shallow water areas of the site to elevation +2-feet NAVD 88 to support land-based installation operations. Rock will be installed at the toe of the sheetpile wall in the deep water area of the site for scour protection. The eastern cell of the waste pit will be protected with a 2-foot layer of granular cover.
- Costs and quantities have been rounded off as appropriate.
- All costs have been provided in 2010 dollars and include material and labor unless otherwise noted. Unit costs are estimated using standard estimating guides (e.g., Means Site Work and Landscape Cost Data), vendors, professional judgment, and experience from similar projects.
- Costs do not include property costs (where applicable), access costs, legal fees, Agency oversight, or public relations efforts.
- These estimates are developed using current and generally accepted engineering cost estimation methods. Note that these estimates are based on assumptions concerning future events and actual costs may be affected by known and unknown risks including, but not limited to, changes in general economic and business conditions, site conditions that were unknown to Anchor QEA at the time the estimates were performed, future changes in site conditions, regulatory or enforcement policy changes, and delays in performance. Actual costs may vary from these estimates and such variations may be material. Anchor QEA is not licensed as accountants or securities attorneys and, therefore, make no representations that these costs form an appropriate basis for complying with financial reporting requirements for such costs.

Notes and Assumptions:

1. Mobilization and demobilization costs include all equipment mob/demob related costs. Includes construction of the site laydown/staging area.
2. Assumes repairing/improving approximately 1,600-feet of roadway at the site. Roadway will be 20-feet wide and will consist of 9-inches of processed concrete rubble. A geotextile layer will be placed beneath the constructed roadway.
3. Environmental control include floating access restriction and reinforced wire fencing construction to limit access to the site.
4. The contractor shall perform a minimum of 3 progress surveys throughout material placement operations. Survey specifications and requirements shall be in accordance with the contract documents.
5. An 18-foot wide rock platform will be constructed along the shallow water areas of the historic berm alignment. This platform will be used to provide access for the sheetpiling equipment and the steel sheeting will be driven through the center of the platform. The platform will be constructed to a minimum elevation of +2-feet NAVD 88 and will have 2H:1V side-slopes on the interior and exterior of the platform.
6. Assumes that a vinyl sheetpile wall will be constructed around the perimeter of the waste pit along the historic berm alignment. The sheetpile wall will be driven through the rock platform in the shallow water areas of the site and will be installed from a barge at water depths reaching up to 16-feet in the deep water area of the site. The sheetpile wall will be installed up to elevation +4-feet NAVD 88.
7. Assumes 12-foot high rock layer on both sides of the sheet pile wall at a 1.5H:1V slope; use bull rock on inside of wall and limestone/granite rock on outside of wall.
8. Granular cover for the eastern cell assumes 0.5 feet of material placed over the specified placement area of the eastern cell and extending into the northern area of the cell. Includes a 0.5 foot overplacement allowance.
9. The outer area of the western cell will be protected by placing a layer of rock along the top-of-slope and by placing a 0.5-foot cover layer over the slope. A geotextile will be placed beneath the cover layer. Assumes construction will disturb 0.5-acre of vegetation on the west cell; areas with disturbed vegetation will receive geotextile and 6-inch granular cover.

**SAN JACINTO RIVER WASTE PIT - TIME CRITICAL REMEDIAL ACTION**

**COST ESTIMATE TABLE**

Alternative 2: Rock Platform Construction, Eastern Cell Composite Sheet Pile Wall with Scour Protection to Historic Impound Limits, Granular Cover to Elevation -1 Inside Wall, Western Cell Control Berm and Shoreline Armoring, Dredging to Geobags in Northwestern Area

| Item No.                                     | Description                                   | Estimated Quantity | Unit  | Unit Price | Estimated Amount    | Notes  |
|--|---|--------------------|-------|------------|---------------------|--|
| <b>Project Set Up</b>                        |   |                    |       |            |                     |  |
| 1  | Mobilization/Demobilization                   | 1                  | LS    | \$ 390,000 | \$ 390,000          | Includes dredging and sheet pile mob/demob costs   |
|  | Health & Safety                               | 1                  | LS    | \$ 56,000  | \$ 56,000           | Planning, staffing and implementation  |
|  | Quality Control                               | 1                  | LS    | \$ 56,000  | \$ 56,000           | Planning, staffing and implementation  |
| 2  | Environmental Controls                        | 1                  | LS    | \$ 172,000 | \$ 172,000          | Maritime signage/fishing advisory markers, reinforced wire fencing, access gates, silt fencing, turbidity curtain          |
| 3  | Access Road Construction                      | 1                  | LS    | \$ 80,000  | \$ 80,000           |  |
| 4  | Survey Control and Material Placement Surveys | 2                  | EA.   | \$ 4,000   | \$ 8,000            |  |
| <b>Eastern Cell Protection</b>               |   |                    |       |            |                     |  |
| 5  | Rock Platform                                 | 14,600             | TONS  | \$ 28.00   | \$ 409,000          | 18-foot wide rock platform for land-based sheetpile wall installation  |
| 6  | Sheetpile Wall Construction                   | 48,300             | SF    | \$ 17.00   | \$ 822,000          | Vinyl sheetpile wall to be installed around the Eastern Cell along the Historic Impoundment Limits to elevation +4 NAVD 88 |
| 7  | Rock Buttress and Scour Protection            |                    |       |            |                     |  |
|  | Inner Wall Protection                         | 2,040              | TONS  | \$ 29.00   | \$ 60,000           | Assumes bull rock 12-ft high inside wall at 1.5H:1V slope  |
|  | Outer Wall Protection                         | 1,980              | TONS  | \$ 70.00   | \$ 139,000          | Assumes large limestone rock 12-ft high inside wall at 1.5H:1V slope   |
| <b>Eastern Cell Protection</b>               |   |                    |       |            |                     |  |
| 8  | Granular Cover                                | 21,700             | TONS  | \$ 29.00   | \$ 630,000          | 8.4 acres, 0.5-ft cover and 0.5-ft overplacement   |
| <b>Western Cell Protection</b>               |   |                    |       |            |                     |  |
| 9  | West Cell Berm                                | 1,800              | TONS  | \$ 28.00   | \$ 51,000           | Rock berm from elevation 0 to +4 along existing western cell shoreline   |
| 10   | Shoreline Armoring                            | 4,700              | TONS  | \$ 68.00   | \$ 320,000          | 0.72 acres. Assume 2.0-foot thick armor layer.   |
|  | Geotextile                                    | 3,840              | SQ YD | \$ 5.00    | \$ 20,000           | Placed beneath shoreline armoring  |
| 11   | Vegetated Area Repair - Geotextile            | 2,670              | SQ YD | \$ 4.00    | \$ 11,000           | Geotextile and granular cover over vegetated areas disturbed by operations   |
| 12   | Vegetated Area Repair - Granular Cover        | 790                | TONS  | \$ 29.00   | \$ 23,000           | Geotextile and granular cover over vegetated areas disturbed by operations   |
| <b>Dredging</b>                              |   |                    |       |            |                     |  |
| 13   | Hydraulic Dredging                            | 4,700              | CY    | \$ 7.00    | \$ 33,000           | 1.2 acres  |
| 14   | Geobag Dewatering                             |                    |       |            |                     |  |
|  | Geotextile                                    | 6,210              | SQ YD | \$ 4.00    | \$ 25,000           | Placed beneath bedding layer   |
|  | Bedding Layer                                 | 700                | CY    | \$ 14.00   | \$ 10,000           | 4-inch bedding layer to protect geobag   |
|  | Purchase and Setup Bags                       | 6                  | EA.   | \$ 16,500  | \$ 99,000           |  |
|  | Maintenance                                   | 6                  | EA.   | \$ 2,000   | \$ 12,000           |  |
| <b>Direct Construction Costs Subtotal</b>    |   |                    |       |            | <b>\$ 3,426,000</b> |  |
| <b>Non-Construction Costs</b>                |   |                    |       |            |                     |  |
| 15   | Contingency                                   |                    |       | 30%        | \$ 1,028,000        |  |
| 16   | Engineering Design                            | 1                  | LS    | \$ 100,000 | \$ 100,000          |  |
| 17   | Construction Management                       |                    |       | 8%         | \$ 274,000          |  |
| 18   | Close Out & Documentation                     |                    |       | 0.50%      | \$ 17,000           |  |
| 19   | Regulatory Compliance Documentation           | 1                  | LS    | \$ 45,000  | \$ 45,000           |  |
| 20   | Environmental Monitoring                      | 4.9                | MO    | \$ 25,000  | \$ 123,000          |  |
| 21   | OM & M  | 1                  | LS    | \$ 68,000  | \$ 68,000           |  |
| <b>In-Direct Construction Costs Subtotal</b> |   |                    |       |            | <b>\$ 1,655,000</b> |  |
| <b>Total Option Costs</b>                    |   |                    |       |            | <b>\$ 5,081,000</b> |  |

**SAN JACINTO RIVER WASTE PIT - TIME CRITICAL REMEDIAL ACTION**  
**COST ESTIMATE TABLE**

Alternative 2: Rock Platform Construction, Eastern Cell Composite Sheet Pile Wall with Scour Protection to Historic Impound Limits, Granular Cover to Elevation -1 Inside Wall, Western Cell Control Berm and Shoreline Armoring, Dredging to Geobags in Northwestern Area

General Comments:

- This alternative includes the operations to complete the recommended Time Critical Remedial Action (TCRA). A vinyl sheetpile wall will be constructed around the perimeter of the eastern cell to the Historical Impoundment Limits. The sheetpile wall will be driven through a rock platform constructed in the shallow water areas of the site to elevation +2-feet NAVD 88 to support land-based installation operations. Rock will be installed at the toe of the sheetpile wall in the deep water area of the site for scour protection. The control berm will be constructed to protect the existing shoreline of the western cell. Additional rock slope protection will be placed in the northwestern area of the site.
- Costs and quantities have been rounded off as appropriate.
- All costs have been provided in 2010 dollars and include material and labor unless otherwise noted. Unit costs are estimated using standard estimating guides (e.g., Means Site Work and Landscape Cost Data), vendors, professional judgment, and experience from similar projects.
- Costs do not include property costs (where applicable), access costs, legal fees, Agency oversight, or public relations efforts. These estimates are developed using current and generally accepted engineering cost estimation methods. Note that these estimates are based on assumptions concerning future events and actual costs may be affected by known and unknown risks including, but not limited to, changes in general economic and business conditions, site conditions that were unknown to Anchor QEA at the time the estimates were performed, future changes in site conditions, regulatory or enforcement policy changes, and delays in performance. Actual costs may vary from these estimates and such variations may be material. Anchor QEA is not licensed as accountants or securities attorneys and, therefore, make no representations that these costs form an appropriate basis for complying with financial reporting requirements for such costs.

Notes and Assumptions:

1. Mobilization and demobilization costs include all equipment mob/demob related costs. Includes construction of the site laydown/staging area.
2. Assumes repairing/improving approximately 1,600-feet of roadway at the site. Roadway will be 20-feet wide and will consist of 9-inches of processed concrete rubble. A geotextile layer will be placed beneath the constructed roadway.
3. Environmental control include floating access restriction and reinforced wire fencing construction to limit access to the site.
4. The contractor shall perform a minimum of 2 progress surveys throughout material placement operations. Survey specifications and requirements shall be in accordance with the contract documents.
5. An 18-foot wide rock platform will be constructed along the shallow water areas of the historic berm alignment around the eastern cell. This platform will be used to provide access for the sheetpiling equipment and the vinyl sheeting will be driven through the center of the platform. The platform will be constructed to a minimum elevation of +2-feet NAVD 88 and will have 2H:1V side-slopes on the interior and exterior of the platform.
6. Assumes that a vinyl sheetpile wall will be constructed around the perimeter of the waste pit along the historic berm alignment around the eastern cell. The sheetpile wall will be installed at water depths reaching up to 12-feet. The sheetpile wall will be installed up to elevation +4-feet NAVD 88.
7. Assumes 12-foot high rock layer on both sides of the sheet pile wall at a 1.5H:1V slope; use bull rock on inside of wall and limestone/granite rock on outside of wall.
8. Granular cover for the eastern cell assumes 0.5 feet of material placed over the specified placement area of the eastern cell and extending into the northern area of the cell. Includes a 0.5 foot overplacement allowance.
9. Western cell berm assumes a 8-foot crest width, 3 Horizontal:1 Vertical (3H:1V) slopes on the outer face and 2H:1V slopes on the inner face. The rock berm will be constructed so that the top-of-berm is at a minimum elevation of +4 NAVD 88. Assumes the rock berm will be constructed of 3- to 5-inch rock.
10. Additional rock protection will be installed on the slopes at the northwestern corner of the cell. The rock protection will be placed in a 2.5-foot thick layer over the area. A geotextile layer will be placed beneath the rock.
- 11, 12. Assumes construction will disturb 0.5-acre of vegetation on the west cell; areas with disturbed vegetation will receive geotextile and 6-inch granular cover.
13. Hydraulic dredging is anticipated to be conducted using a 6- to 8-inch diameter dredge. Dredging will be conducted 24 hours per day, 6 days per week and is estimated to operate at a 150 cy/hour production rate. Assumes 75% uptime.
14. Dredged material will be pumped directly in to geobags staged on the western cell of the waste pit. The dewatering area will be covered with a geotextile layer, topped by a 4-inch bedding layer. It is anticipated that six 900-cubic yard geobags will be required to accommodate the total estimated dredge volume.

**SAN JACINTO RIVER WASTE PIT - TIME CRITICAL REMEDIAL ACTION**  
**COST ESTIMATE TABLE**

Alternative 3: Granular Cover over Eastern Cell, Eastern Cell Clay Cover and Rock Cover Layers, Western Cell Control Berm, Granular Cover in Northwestern Area

| Item No.                                     | Description                            | Estimated Quantity | Unit  | Unit Price | Estimated Amount    | Notes   |
|--|--|--------------------|-------|------------|---------------------|---|
| 1  | Mobilization/Demobilization            | 1                  | LS    | \$ 250,000 | \$ 250,000          |   |
|  | Health & Safety                        | 1                  | LS    | \$ 32,000  | \$ 32,000           | Planning, staffing and implementation   |
|  | Quality Control                        | 1                  | LS    | \$ 32,000  | \$ 32,000           | Planning, staffing and implementation   |
| 2  | Access Road Construction               | 1                  | LS    | \$ 80,000  | \$ 80,000           |   |
| 3  | Environmental Controls                 | 1                  | LS    | \$ 172,000 | \$ 172,000          | Maritime signage/fishing advisory markers, reinforced wire fencing, access gates, silt fencing, turbidity curtain |
| 4  | Perform 3 Material Placement Surveys   | 3                  | EA.   | \$ 4,000   | \$ 12,000           |   |
| <b>Eastern Cell Protection</b>               |  |                    |       |            |                     |   |
| 5  | Granular Cover                         | 25,000             | TONS  | \$ 29.00   | \$ 725,000          | 7.34 acres; includes area of thickened fill to Ele. -2 for Hydraulic Cutoff                                       |
| 6  | Rock Cover                             | 7,200              | TONS  | \$ 68.00   | \$ 490,000          | 1.08 acres; includes area of thickened fill to Ele. -2 for Hydraulic Cutoff                                       |
|  | Geotextile                             | 5,750              | SQ YD | \$ 5.00    | \$ 29,000           | Placed beneath rock cover layer   |
| <b>Western Cell Protection</b>               |  |                    |       |            |                     |   |
| 7  | West Cell Berm                         | 1,800              | TONS  | \$ 28.00   | \$ 51,000           | Rock berm from elevation 0 to +4 along existing western cell shoreline  |
| 8  | Shoreline Armoring                     | 4,700              | TONS  | \$ 68.00   | \$ 320,000          | 0.72 acres  |
|  | Geotextile                             | 3,840              | SQ YD | \$ 5.00    | \$ 20,000           | Placed beneath shoreline armoring   |
| 9  | Vegetated Area Repair - Geotextile     | 2,670              | SQ YD | \$ 4.00    | \$ 11,000           | Geotextile and granular cover over vegetated areas disturbed by operations  |
| 10   | Vegetated Area Repair - Granular Cover | 790                | TONS  | \$ 29.00   | \$ 23,000           | Geotextile and granular cover over vegetated areas disturbed by operations  |
| <b>Northwestern Area</b>                     |  |                    |       |            |                     |   |
| 11   | Granular Cover                         | 3,300              | TONS  | \$ 29.00   | \$ 96,000           | 1.2 acres   |
| <b>Direct Construction Costs Subtotal</b>    |  |                    |       |            | <b>\$ 2,343,000</b> |   |
| <b>Non-Construction Costs</b>                |  |                    |       |            |                     |   |
| 12   | Contingency                            |                    |       | 30%        | \$ 703,000          |   |
| 13   | Engineering Design                     | 1                  | LS    | \$ 100,000 | \$ 100,000          |   |
| 14   | Construction Management                |                    |       | 8%         | \$ 188,000          |   |
| 15   | Close Out & Documentation              |                    |       | 0.50%      | \$ 12,000           |   |
| 16   | Regulatory Compliance Documentation    | 1                  | LS    | \$ 45,000  | \$ 45,000           |   |
| 17   | Environmental Monitoring               | 2.7                | MO    | \$ 25,000  | \$ 68,000           |   |
| 18   | OM & M                                 | 1                  | LS    | \$ 97,000  | \$ 97,000           |   |
| <b>In-Direct Construction Costs Subtotal</b> |  |                    |       |            | <b>\$ 1,213,000</b> |   |
| <b>Total Option Costs</b>                    |  |                    |       |            | <b>\$ 3,556,000</b> |   |

**SAN JACINTO RIVER WASTE PIT - TIME CRITICAL REMEDIAL ACTION**  
**COST ESTIMATE TABLE**

Alternative 3: Granular Cover over Eastern Cell, Eastern Cell Clay Cover and Rock Cover Layers, Western Cell Control Berm, Granular Cover in Northwestern Area

General Comments:

- This alternative includes the operations to complete the recommended Time Critical Remedial Action (TCRA). The eastern cell of the waste pit will be covered with a granular layer designed to resist the anticipated erosional forces that will act upon the cell during the governing storm event flow. Along the perimeter of the sand/gravel layer placement, a 2-foot thick rock layer will be placed. At the northern extents of the site where water depths reach up to -18-ft, additional granular fill and rock protection will be placed to achieve an elevation of -2-ft for hydraulic cutoff of the deep channel. Additional rock slope protection will be placed in the northwestern corner of the cell.
- Costs and quantities have been rounded off as appropriate.
- All costs have been provided in 2010 dollars and include material and labor unless otherwise noted. Unit costs are estimated using standard estimating guides (e.g., Means Site Work and Landscape Cost Data), vendors, professional judgment, and experience from similar projects.
- Costs do not include property costs (where applicable), access costs, legal fees, Agency oversight, or public relations efforts.
- These estimates are developed using current and generally accepted engineering cost estimation methods. Note that these estimates are based on assumptions concerning future events and actual costs may be affected by known and unknown risks including, but not limited to, changes in general economic and business conditions, site conditions that were unknown to Anchor QEA at the time the estimates were performed, future changes in site conditions, regulatory or enforcement policy changes, and delays in performance. Actual costs may vary from these estimates and such variations may be material. Anchor QEA is not licensed as accountants or securities attorneys and, therefore, make no representations that these costs form an appropriate basis for complying with financial reporting requirements for such costs.

Notes and Assumptions:

1. Mobilization and demobilization costs include all equipment mob/demob related costs. Includes construction of the site laydown/staging area.
2. Assumes repairing/improving approximately 1,600-feet of roadway at the site. Roadway will be 20-feet wide and will consist of 9-inches of processed concrete rubble. A geotextile layer will be placed beneath the constructed roadway.
3. Environmental control include floating access restriction and reinforced wire fencing construction to limit access to the site.
4. The contractor shall perform a minimum of 3 progress surveys throughout material placement operations. Survey specifications and requirements shall be in accordance with the contract documents.
5. Granular cover for the eastern cell assumes 0.5 feet of material placed over the specified placement area. Includes a 0.5 foot overplacement allowance.
6. Assumes a 2-foot thick rock cover placed over a 1.08-acre on the outer-most region of the eastern cell. A geotextile layer will be placed beneath the rock cover.
7. Western cell berm assumes a 8-foot crest width, 3 Horizontal:1 Vertical (3H:1V) slopes on the outer face and 2H:1V slopes on the inner face. The rock berm will be constructed so that the top-of-berm is at a minimum elevation of +4 NAVD 88. Assumes the rock berm will be constructed of 3- to 5-inch rock. Assumes a conversion factor of 1.9 tons/cubic yard.
8. Assumes placement of a 2.5-foot thick rock armor layer over the entire 0.72-acre shoreline armoring area adjacent to the western cell. A geotextile layer will be placed beneath the rock.
- 9, 10. Assumes construction will disturb 0.5-acre of vegetation on the west cell; areas with disturbed vegetation will receive geotextile and 6-inch granular cover.
11. Additional cover will be installed on the slopes at the northwestern corner of the cell. The granular cover layer will cover from +1 NAVD 88 to -14 NAVD 88. The granular cover will be 0.5-feet thick with a 0.5-foot allowable overplacement.



**SAN JACINTO RIVER WASTE PIT - TIME CRITICAL REMEDIAL ACTION**  
**COST ESTIMATE TABLE**

Alternative 4: Granular Cover over Eastern Cell, Eastern Cell Earth Berm and Rock Berm to Elevation +1, Western Cell Control Berm and Shoreline Armoring, Granular Cover in Northwestern Area

| Item No.                                     | Description                                   | Estimated Quantity | Unit  | Unit Price | Estimated Amount    | Notes   |
|--|---|--------------------|-------|------------|---------------------|---|
| 1  | Mobilization/Demobilization                   | 1                  | LS    | \$ 280,000 | \$ 280,000          |   |
|  | Health & Safety                               | 1                  | LS    | \$ 31,000  | \$ 31,000           | Planning, staffing and implementation   |
|  | Quality Control                               | 1                  | LS    | \$ 31,000  | \$ 31,000           | Planning, staffing and implementation   |
| 2  | Access Road Construction                      | 1                  | LS    | \$ 80,000  | \$ 80,000           |   |
| 3  | Environmental Controls                        | 1                  | LS    | \$ 172,000 | \$ 172,000          | Maritime signage/fishing advisory markers, reinforced wire fencing, access gates, silt fencing, turbidity curtain |
| 4  | Survey Control and Material Placement Surveys | 3                  | EA.   | \$ 4,000   | \$ 12,000           |   |
| <b>Eastern Cell Protection</b>               |   |                    |       |            |                     |   |
| 5  | Granular Cover                                | 22,600             | TONS  | \$ 29.00   | \$ 656,000          | 7.34 acres; 0.5-ft cover and 0.5-ft overplacement   |
| 6  | TCRA Rock Berm                                | 12,600             | TONS  | \$ 68.00   | \$ 857,000          | 1.08 acres; rock berm to be constructed to elevation +1 NAVD 88   |
|  | Geotextile                                    | 6,260              | SQ YD | \$ 5.00    | \$ 32,000           | Placed beneath TCRA rock berm   |
| <b>Western Cell Protection</b>               |   |                    |       |            |                     |   |
| 7  | West Cell Berm                                | 1,800              | TONS  | \$ 28.00   | \$ 51,000           | Rock berm from elevation 0 to +4 along existing western cell shoreline  |
| 8  | Shoreline Armoring                            | 4,700              | TONS  | \$ 68.00   | \$ 320,000          | 0.72 acres  |
|  | Geotextile                                    | 3,840              | SQ YD | \$ 5.00    | \$ 20,000           | Placed beneath shoreline armoring   |
| 9  | Vegetated Area Repair - Geotextile            | 2,670              | SQ YD | \$ 4.00    | \$ 11,000           | Geotextile and granular cover over vegetated areas disturbed by operations  |
| 10   | Vegetated Area Repair - Granular Cover        | 790                | TONS  | \$ 29.00   | \$ 23,000           | Geotextile and granular cover over vegetated areas disturbed by operations  |
| <b>Northwestern Area</b>                     |   |                    |       |            |                     |   |
| 11   | Granular Cover                                | 3,300              | TONS  | \$ 29.00   | \$ 96,000           | 1.2 acres   |
| <b>Direct Construction Costs Subtotal</b>    |   |                    |       |            | <b>\$ 2,672,000</b> |   |
| <b>Non-Construction Costs</b>                |   |                    |       |            |                     |   |
| 12   | Contingency                                   |                    |       | 30%        | \$ 802,000          |   |
| 13   | Engineering Design                            | 1                  | LS    | \$ 100,000 | \$ 100,000          |   |
| 14   | Construction Management                       |                    |       | 8%         | \$ 214,000          |   |
| 15   | Close Out & Documentation                     |                    |       | 0.50%      | \$ 14,000           |   |
| 16   | Regulatory Compliance Documentation           | 1                  | LS    | \$ 45,000  | \$ 45,000           |   |
| 17   | Environmental Monitoring                      | 2.6                | MO    | \$ 25,000  | \$ 66,000           |   |
| 18   | OM & M  | 1                  | LS    | \$ 110,000 | \$ 110,000          |   |
| <b>In-Direct Construction Costs Subtotal</b> |   |                    |       |            | <b>\$ 1,351,000</b> |   |
| <b>Total Option Costs</b>                    |   |                    |       |            | <b>\$ 4,023,000</b> |   |

**SAN JACINTO RIVER WASTE PIT - TIME CRITICAL REMEDIAL ACTION**  
**COST ESTIMATE TABLE**

Alternative 4: Granular Cover over Eastern Cell, Eastern Cell Earth Berm and Rock Berm to Elevation +1, Western Cell Control Berm and Shoreline Armoring, Granular Cover in Northwestern Area

General Comments:

- This alternative includes the operations to complete the recommended Time Critical Remedial Action (TCRA). A rock berm will be constructed around the perimeter of the eastern cell. Additional rock slope protection will be placed in the northwestern corner of the cell. The eastern cell of the waste pit will be covered with a granular layer designed to resist the anticipated erosional forces that will act upon the cell during the governing storm event flow.
- Costs and quantities have been rounded off as appropriate.
- All costs have been provided in 2010 dollars and include material and labor unless otherwise noted. Unit costs are estimated using standard estimating guides (e.g., Means Site Work and Landscape Cost Data), vendors, professional judgment, and experience from similar projects.
- Costs do not include property costs (where applicable), access costs, legal fees, Agency oversight, or public relations efforts.
- These estimates are developed using current and generally accepted engineering cost estimation methods. Note that these estimates are based on assumptions concerning future events and actual costs may be affected by known and unknown risks including, but not limited to, changes in general economic and business conditions, site conditions that were unknown to Anchor QEA at the time the estimates were performed, future changes in site conditions, regulatory or enforcement policy changes, and delays in performance. Actual costs may vary from these estimates and such variations may be material. Anchor QEA is not licensed as accountants or securities attorneys and, therefore, make no representations that these costs form an appropriate basis for complying with financial reporting requirements for such costs.

Notes and Assumptions:

1. Mobilization and demobilization costs include all equipment mob/demob related costs. Includes construction of the site laydown/staging area.
2. Assumes repairing/improving approximately 1,600-feet of roadway at the site. Roadway will be 20-feet wide and will consist of 9-inches of processed concrete rubble. A geotextile layer will be placed beneath the constructed roadway.
3. Environmental control include floating access restriction and reinforced wire fencing construction to limit access to the site.
4. The contractor shall perform a minimum of 3 progress surveys throughout material placement operations. Survey specifications and requirements shall be in accordance with the contract documents.
5. Granular cover for the eastern cell assumes 0.5 feet of material placed over the specified placement area. Includes a 0.5 foot overplacement allowance.
6. TCRA rock berms assumes a 10-foot crest width, 3 Horizontal:1 Vertical (3H:1V) slopes on the outer face and 2H:1V slopes on the inner face. The rock berm will be constructed so that the top-of-berm is at a minimum elevation of +1 NAVD 88. Assumes the rock berm will be constructed of 3- to 5-inch rock. Assumes a conversion factor of 1.9 tons/cubic yard. A geotextile layer will be placed beneath the rock berm.
7. Western cell berm assumes a 8-foot crest width, 3 Horizontal:1 Vertical (3H:1V) slopes on the outer face and 2H:1V slopes on the inner face. The rock berm will be constructed so that the top-of-berm is at a minimum elevation of +4 NAVD 88. Assumes the rock berm will be constructed of 3- to 5-inch rock. Assumes a conversion factor of 1.9 tons/cubic yard.
8. Assumes placement of a 2.5-foot thick rock armor layer over the entire 0.72-acre shoreline armoring area adjacent to the western cell. A geotextile layer will be placed beneath the rock.
- 9, 10. Assumes construction will disturb 0.5-acre of vegetation on the west cell; areas with disturbed vegetation will receive geotextile and 6-inch granular cover.
11. Additional cover will be installed on the slopes at the northwestern corner of the cell. The granular cover layer will cover from +1 NAVD 88 to -14 NAVD 88. The granular cover will be 0.5-feet thick with a 0.5-foot allowable overplacement.

**SAN JACINTO RIVER WASTE PIT - TIME CRITICAL REMEDIAL ACTION**  
**COST ESTIMATE TABLE**

Alternative 5: Western Cell Control Berm, ACBM Cover over entire Eastern Cell and Shoreline of Western Cell, Dredging to Geobags in Northwestern Area

| Item No.                                     | Description                            | Estimated Quantity | Unit  | Unit Price | Estimated Amount    | Notes   |
|--|--|--------------------|-------|------------|---------------------|---|
| 1  | Mobilization/Demobilization            | 1                  | LS    | \$ 575,000 | \$ 575,000          | Includes dredging mob/demob costs   |
|  | Health & Safety                        | 1                  | LS    | \$ 31,000  | \$ 31,000           | Planning, staffing and implementation   |
|  | Quality Control                        | 1                  | LS    | \$ 31,000  | \$ 31,000           | Planning, staffing and implementation   |
| 2  | Access Road Construction               | 1                  | LS    | \$ 80,000  | \$ 80,000           |   |
| 3  | Environmental Controls                 | 1                  | LS    | \$ 172,000 | \$ 172,000          | Maritime signage/fishing advisory markers, reinforced wire fencing, access gates, silt fencing, turbidity curtain |
| 4  | Perform 3 Material Placement Surveys   | 3                  | EA.   | \$ 4,000   | \$ 12,000           |   |
| <b>Eastern Cell Protection</b>               |  |                    |       |            |                     |   |
| 5  | ACBM Placement over Eastern Cell       | 369,400            | SF    | \$ 8.00    | \$ 2,956,000        | 8.48 acres  |
| <b>Western Cell Protection</b>               |  |                    |       |            |                     |   |
| 6  | West Cell Berm                         | 1,800              | TONS  | \$ 28.00   | \$ 51,000           | Rock berm from elevation 0 to +4 along existing western cell shoreline  |
| 7  | ACBM Shoreline Armoring                | 31,400             | SF    | \$ 8.00    | \$ 252,000          | 0.72 acres  |
| 8  | Vegetated Area Repair - Geotextile     | 2,670              | SQ YD | \$ 4.00    | \$ 11,000           | Geotextile and granular cover over vegetated areas disturbed by operations  |
| 9  | Vegetated Area Repair - Granular Cover | 790                | TONS  | \$ 29.00   | \$ 23,000           | Geotextile and granular cover over vegetated areas disturbed by operations  |
| <b>Scour Protection Apron</b>                |  |                    |       |            |                     |   |
| 10   | Scour Protection                       | 5,100              | TONS  | \$ 70.00   | \$ 357,000          | Assumes 15-foot wide scour protection apron at toe of ACBM  |
| <b>Dredging</b>                              |  |                    |       |            |                     |   |
| 11   | Hydraulic Dredging                     | 4,700              | CY    | \$ 7.00    | \$ 33,000           | 1.2 acres   |
| 12   | Geobag Dewatering                      |                    |       |            |                     |   |
|  | Geotextile                             | 6,210              | SQ YD | \$ 4       | \$ 25,000           | Placed beneath the bedding layer  |
|  | Bedding Layer                          | 700                | CY    | \$ 14      | \$ 10,000           | 4-inch bedding layer to protect geobag  |
|  | Purchase and Setup Bags                | 6                  | EA.   | \$ 16,500  | \$ 99,000           |   |
|  | Maintenance                            | 6                  | EA.   | \$ 2,000   | \$ 12,000           |   |
| <b>Direct Construction Costs Subtotal</b>    |  |                    |       |            | <b>\$ 4,730,000</b> |   |
| <b>Non-Construction Costs</b>                |  |                    |       |            |                     |   |
| 13   | Contingency                            |                    |       | 30%        | \$ 1,419,000        |   |
| 14   | Engineering Design                     | 1                  | LS    | \$ 100,000 | \$ 100,000          |   |
| 15   | Construction Management                |                    |       | 8%         | \$ 379,000          |   |
| 16   | Close Out & Documentation              |                    |       | 0.50%      | \$ 24,000           |   |
| 17   | Regulatory Compliance Documentation    | 1                  | LS    | \$ 45,000  | \$ 45,000           |   |
| 18   | Environmental Monitoring               | 2.6                | MO    | \$ 25,000  | \$ 65,000           |   |
| 19   | OM & M                                 | 1                  | LS    | \$ 181,000 | \$ 181,000          |   |
| <b>In-Direct Construction Costs Subtotal</b> |  |                    |       |            | <b>\$ 2,213,000</b> |   |
| <b>Total Option Costs</b>                    |  |                    |       |            | <b>\$ 6,943,000</b> |   |

**SAN JACINTO RIVER WASTE PIT - TIME CRITICAL REMEDIAL ACTION  
COST ESTIMATE TABLE**

Alternative 5: Western Cell Control Berm, ACBM Cover over entire Eastern Cell and Shoreline of Western Cell, Dredging to Geobags in Northwestern Area

General Comments:

- This alternative includes the operations to complete the recommended Time Critical Remedial Action (TCRA). ACBM will be placed over the entirety of the eastern cell to the Historical Impoundment Limits and along the shoreline of the western cell to protect the western cell control berm. The control berm will be constructed to protect the existing shoreline of the western cell. Additional rock slope protection will be placed in the northwestern area of the site.
- Costs and quantities have been rounded off as appropriate.
- All costs have been provided in 2010 dollars and include material and labor unless otherwise noted. Unit costs are estimated using standard estimating guides (e.g., Means Site Work and Landscape Cost Data), vendors, professional judgment, and experience from similar projects.
- Costs do not include property costs (where applicable), access costs, legal fees, Agency oversight, or public relations efforts.
- These estimates are developed using current and generally accepted engineering cost estimation methods. Note that these estimates are based on assumptions concerning future events and actual costs may be affected by known and unknown risks including, but not limited to, changes in general economic and business conditions, site conditions that were unknown to Anchor QEA at the time the estimates were performed, future changes in site conditions, regulatory or enforcement policy changes, and delays in performance. Actual costs may vary from these estimates and such variations may be material. Anchor QEA is not licensed as accountants or securities attorneys and, therefore, make no representations that these costs form an appropriate basis for complying with financial reporting requirements for such costs.

Notes and Assumptions:

1. Mobilization and demobilization costs include all equipment mob/demob related costs. Includes construction of the site laydown/staging area.
2. Assumes repairing/improving approximately 1,600-feet of roadway at the site. Roadway will be 20-feet wide and will consist of 9-inches of processed concrete rubble. A geotextile layer will be placed beneath the constructed roadway.
3. Environmental control include floating access restriction and reinforced wire fencing construction to limit access to the site.
4. Assumes ACBM placement over a 8.48-acre area of the eastern cell and northern portion of the site.
5. Western cell berm assumes a 8-foot crest width, 3 Horizontal:1 Vertical (3H:1V) slopes on the outer face and 2H:1V slopes on the inner face. The rock berm will be constructed so that the top-of-berm is at a minimum elevation of +4 NAVD 88. Assumes the rock berm will be constructed of 3- to 5-inch rock. Assumes a conversion factor of 1.9 tons/cubic yard.
6. Assumes placement of ACBM over the entire 0.72-acre shoreline armoring area adjacent to the western cell.
- 7, 8. Assumes construction will disturb 0.5-acre of vegetation on the west cell; areas with disturbed vegetation will receive geotextile and 6-inch granular cover.
9. Assumes a 15-foot wide scour protection apron placed at the toe of slope of the ACBM placement .
10. The contractor shall perform a minimum of 3 progress surveys throughout material placement operations. Survey specifications and requirements shall be in accordance with the contract documents.
11. Hydraulic dredging is anticipated to be conducted using a 6- to 8-inch diameter dredge. Dredging will be conducted 24 hours per day, 6 days per week and is estimated to operate at a 150 cy/hour production rate. Assumes 75% uptime.
12. Dredged material will be pumped directly in to geobags staged on the western cell of the waste pit. The dewatering area will be covered with a geotextile layer, topped by a 4-inch bedding layer. It is anticipated that six 900-cubic yard geobags will be required to accommodate the total estimated dredge volume.

## QUANTITIES COMMON TO ALL ALTERNATIVES

### **Item 2 Access Road Construction**

#### Key Assumptions:

Construct an all weather Access Road from the Big Star Property to the site.

Consists of three items:

1. 9-inch thick surface course (processed concrete rubble)
2. geotextile fabric underlayment
3. equipment and labor costs to install geotextile and surface course

#### Surface Course Volume:

|   | Dimension | Unit |
|---|-----------|------|
| length of improved area for road                        | 1600      | FT   |
| width of improved area for road                         | 20        | FT   |
| width of laydown area                                   | 20        | FT   |
| length of laydown area                                  | 20        | FT   |
| thickness of surface course (processed concrete rubble) | 0.75      | FT   |
| volume of surface course material                       | 900       | CY   |

#### Surface Course Weight:

|  |      |        |
|--|------|--------|
| conversion to tons from Southern Crushed Conc. | 2    | Ton/CY |
| surface course                                 | 1800 | Tons   |

#### Geotextile:

|                                  |      |    |
|----------------------------------|------|----|
| length of improved area for road | 1600 | FT |
| width of improved area for road  | 20   | FT |
| width of laydown area            | 20   | FT |
| length of laydown area           | 20   | FT |
| geotextile fabric underlayment   | 3600 | SY |

#### Equipment and Labor:

| <u>Labor</u>        | Hours | Rate            | Total   |
|---------------------|-------|-----------------|---------|
| Superintendent      | 40    | \$30            | \$1,200 |
| Equipment Operators | 100   | \$32            | \$3,200 |
| Laborers            | 40    | \$15            | \$600   |
|                     |       |                 | \$5,000 |
| Fringes             |       | 55%             | \$2,750 |
| Home OH             |       | 2%              | \$200   |
|                     |       | Labor Subtotal: | \$7,950 |

#### Equipment

|                       |    |                     |          |
|-----------------------|----|---------------------|----------|
| Truck                 | 40 | \$50                | \$2,000  |
| Dozer                 | 50 | \$80                | \$4,000  |
| Excavator             | 50 | \$120               | \$6,000  |
| Mob via truck to site | 2  | \$1,500             | \$3,000  |
|                       |    | Equipment Subtotal: | \$15,000 |

|                               |     |          |
|-------------------------------|-----|----------|
| Labor and Equipment Subtotal: |     | \$22,950 |
| Labor and Equipment Overhead: | 12% | \$2,800  |
| Labor and Equipment Total:    |     | \$25,750 |

|                            |     |
|----------------------------|-----|
| Access Road Profit Margin: | 10% |
|----------------------------|-----|

## **ALTERNATIVE 1 QUANTITIES**

### **Item 4 Perform Material Placement Surveys**

Material placement surveys to verify material quantities 3

### **Item 5 Rock Platform**

#### **Key Assumptions:**

18 foot wide berm at crest  
Top elevation +2 feet  
2H:1V side slopes  
Assumed 6 inches of consolidation during construction  
Berm needed in shallow waters only (2,000 feet total berm length, of which 1,250 feet are in shallow water at southern portion of sheet pile wall)

#### **Volume:**

|                                    |         |       |
|------------------------------------|---------|-------|
| Length of Rock Platform            | 1,250   | FT    |
| Width of Rock Platform at Crest    | 18      | FT    |
| Bottom of Platform Elev. (NAVD 88) | -4      | FT    |
| Top of Platform Elev. (NAVD 88)    | 2       | FT    |
| Side Slopes (XH:1V)                | 2       |       |
| Volume of Rock                     | 225,000 | CU FT |
| Volume of Rock                     | 8,333   | CY    |

#### **Weight:**

|                             |        |        |
|-----------------------------|--------|--------|
| Assumed unit weight of rock | 1.9    | TON/CY |
| Weight of Rock              | 15,900 | TON    |

### **Item 6 Sheetpile Wall**

#### **Key Assumptions:**

|   |        |       |
|---|--------|-------|
| Shallow water sheet pile top elevation: | 4      | FT    |
| Shallow water sheet pile tip elevation: | -20    | FT    |
| Shallow water sheet pile length :       | 24     | FT    |
| Shallow water length of piling:         | 1,250  | FT    |
| Shallow water sheet pile area:          | 30,000 | SQ FT |

|                                      |        |       |
|--------------------------------------|--------|-------|
| Deep water sheet pile top elevation: | 4      | FT    |
| Deep water sheet pile tip elevation: | -56    | FT    |
| Deep water sheet pile length:        | 60     | FT    |
| Deep water length of piling:         | 750    | FT    |
| Deep water sheet pile area:          | 45,000 | SQ FT |

|   |     |  |
|---|-----|--|
| Contingency for sheet pile length pending design: | 15% |  |
|---|-----|--|

|                 |        |       |
|-----------------|--------|-------|
| Sheet pile area | 86,250 | SQ FT |
|-----------------|--------|-------|

## **ALTERNATIVE 1 QUANTITIES**

### **Item 7 Rock Buttress and Scour Protection**

#### **Key Assumptions:**

Use 3" x 5" bull rock (crushed concrete) as scour protection on inside of sheet pile wall

Use large rock (limestone/granite rock) on outside of sheet pile wall

Length of scour protection area 750 FT

Height of scour protection area 12 FT

Width of scour protection area (assume 1.5H:1V) 18 FT

#### **Volume:**

Volume on each side of wall 3,000 CY

#### **Weight:**

Assumed Unit Weight, inside of wall 1.7 TONS/CY

Total Weight, inside of wall 5,100 TONS

Assumed Unit Weight, outside of wall 1.65 TONS/CY

Total Weight, outside of wall 4,950 TONS

### **Item 8 Eastern Cell Granular Cover**

#### **Key Assumptions:**

Layer thickness of granular material 0.5 FT

Overplacement allowance 0.5 FT

Area of granular material placement 10.44 ACRE

#### **Volume:**

Area of granular material placement 454,766 SQ FT

Volume of granular material (not including overplacement) 8,430 CY

Volume of granular material (including overplacement) 16,850 CY

#### **Weight:**

Assumed unit weight of granular protection material 1.6 TONS/CY

Tons of granular material 27,000 TONS



## **ALTERNATIVE 1 QUANTITIES**

### **Item 9 Western Cell Cover**

#### **Rock Protection**

##### Key Assumptions:

|                 |     |    |
|-----------------|-----|----|
| Layer Thickness | 1.0 | FT |
| Width           | 40  | FT |
| Length          | 350 | FT |

##### Volume:

|                 |     |    |
|-----------------|-----|----|
| Rock Protection | 519 | CY |
|-----------------|-----|----|

##### Weight:

|                     |     |         |
|---------------------|-----|---------|
| Assumed Unit Weight | 1.9 | TONS/CY |
| Total Weight        | 990 | TONS    |

#### **Granular Cover**

##### Key Assumptions:

|  |       |       |
|--|-------|-------|
| Layer Thickness                              | 0.5   | FT    |
| Width  | 125   | FT    |
| Length                                       | 350   | FT    |
| Geotextile (Includes 10% overlapping factor) | 5,350 | SQ YD |

##### Volume:

|                 |     |    |
|-----------------|-----|----|
| Rock Protection | 810 | CY |
|-----------------|-----|----|

##### Weight:

|                     |       |         |
|---------------------|-------|---------|
| Assumed Unit Weight | 1.6   | TONS/CY |
| Total Weight        | 1,300 | TONS    |

#### **Vegetated Area Repair**

##### Key Assumptions:

Disturbed areas will receive geotextile placement and granular cover.

|   |     |      |
|---|-----|------|
| Area disturbed by operations requiring repair | 0.5 | ACRE |
|---|-----|------|

|                             |     |    |
|-----------------------------|-----|----|
| Thickness of granular cover | 0.5 | FT |
|-----------------------------|-----|----|

##### Geotextile Area:

|                |        |       |
|----------------|--------|-------|
| Disturbed area | 21,780 | SQ FT |
| Overplacement  | 10%    |       |
| Geotextile     | 23,958 | SQ FT |
| Geotextile     | 2,670  | SQ YD |

##### Granular Cover

##### Volume:

|                                     |     |    |
|-------------------------------------|-----|----|
| Granular Cover                      | 403 | CY |
| Overplacement and loss of materials | 20% |    |
| Granular Cover                      | 490 | CY |

##### Weight:

|                     |     |         |
|---------------------|-----|---------|
| Assumed Unit Weight | 1.6 | TONS/CY |
| Total Weight        | 790 | TONS    |

## **ALTERNATIVE 2 QUANTITIES**

### **Item 4 Perform Material Placement Surveys**

|  |   |
|--|---|
| Material placement surveys to verify material quantities | 2 |
|--|---|

### **Item 5 Rock Platform**

#### **Key Assumptions:**

18 foot wide berm at crest  
Top elevation +2 feet  
2H:1V side slopes  
Assumed 6 inches of consolidation during construction  
Berm needed in shallow waters only (2,000 feet total berm length, of which 1,250 feet are in shallow water at southern portion of sheet pile wall)

#### **Volume:**

|                                    |         |       |
|------------------------------------|---------|-------|
| Length of Rock Platform            | 1,150   | FT    |
| Width of Rock Platform at Crest    | 18      | FT    |
| Bottom of Platform Elev. (NAVD 88) | -4      | FT    |
| Top of Platform Elev. (NAVD 88)    | 2       | FT    |
| Side Slopes (XH:1V)                | 2       |       |
| Volume of Rock                     | 207,000 | CU FT |
| Volume of Rock                     | 7,667   | CY    |

#### **Weight:**

|                             |        |        |
|-----------------------------|--------|--------|
| Assumed unit weight of rock | 1.9    | TON/CY |
| Weight of Rock              | 14,600 | TON    |

### **Item 6 Sheetpile Wall**

#### **Key Assumptions:**

|   |        |       |
|---|--------|-------|
| Shallow water sheet pile top elevation: | 4      | FT    |
| Shallow water sheet pile tip elevation: | -20    | FT    |
| Shallow water sheet pile length :       | 24     | FT    |
| Shallow water length of piling:         | 1,150  | FT    |
| Shallow water sheet pile area:          | 27,600 | SQ FT |

|                                      |        |       |
|--------------------------------------|--------|-------|
| Deep water sheet pile top elevation: | 4      | FT    |
| Deep water sheet pile tip elevation: | -44    | FT    |
| Deep water sheet pile length:        | 48     | FT    |
| Deep water length of piling:         | 300    | FT    |
| Deep water sheet pile area:          | 14,400 | SQ FT |

|   |     |
|---|-----|
| Contingency for sheet pile length pending design: | 15% |
|---|-----|

|                 |        |       |
|-----------------|--------|-------|
| Sheet pile area | 48,300 | SQ FT |
|-----------------|--------|-------|

## **ALTERNATIVE 2 QUANTITIES**

### **Item 7 Rock Buttress and Scour Protection**

#### **Key Assumptions:**

|   |     |    |
|---|-----|----|
| Use 3" x 5" bull rock (crushed concrete) as scour protection on inside of sheet pile wall |     |    |
| Use large rock (limestone/granite rock) on outside of sheet pile wall                     |     |    |
| Length of scour protection area   | 300 | FT |
| Height of scour protection area   | 12  | FT |
| Width of scour protection area (assume 1.5H:1V)   | 18  | FT |

#### **Volume:**

|                             |       |    |
|-----------------------------|-------|----|
| Volume on each side of wall | 1,200 | CY |
|-----------------------------|-------|----|

#### **Weight:**

|                                      |       |         |
|--------------------------------------|-------|---------|
| Assumed Unit Weight, inside of wall  | 1.7   | TONS/CY |
| Total Weight, inside of wall         | 2,040 | TONS    |
| Assumed Unit Weight, outside of wall | 1.7   | TONS/CY |
| Total Weight, outside of wall        | 1,980 | TONS    |

### **Item 8 Eastern Cell Granular Cover**

#### **Key Assumptions:**

|                                      |      |      |
|--------------------------------------|------|------|
| Layer thickness of granular material | 0.5  | FT   |
| Overplacement Allowance              | 0.5  | FT   |
| Area of granular material placement  | 8.40 | ACRE |

#### **Volume:**

|   |         |       |
|---|---------|-------|
| Area of granular material placement                       | 365,904 | SQ FT |
| Volume of granular material (not including overplacement) | 6,780   | CY    |
| Volume of granular material (including overplacement)     | 13,560  | CY    |

#### **Weight:**

|   |        |         |
|---|--------|---------|
| Assumed unit weight of granular protection material | 1.6    | TONS/CY |
| Tons of granular material                           | 21,700 | TONS    |

### **Item 9 Western Cell Berm**

#### **Key Assumptions**

|                          |     |    |
|--------------------------|-----|----|
| Exterior Slope (XH:1V)   | 3   |    |
| Interior Slope (XH:1V)   | 2   |    |
| Bottom of berm elevation | 0   | FT |
| Top of berm elevation    | 4   | FT |
| Width of berm at crest   | 8   | FT |
| Length of berm           | 350 | FT |

#### **Volume:**

|                             |     |       |
|-----------------------------|-----|-------|
| Berm Volume per linear foot | 72  | CU FT |
| Berm Volume                 | 933 | CY    |

#### **Weight:**

|   |       |        |
|---|-------|--------|
| Assumed unit weight of granular protection material | 1.9   | TON/CY |
| Tons of material                                    | 1,800 |        |

### **Item 10 Shoreline Armoring**

#### **Key Assumptions**

|  |       |       |
|--|-------|-------|
| Layer thickness                              | 2.0   | FT    |
| West cell shoreline armoring area            | 0.72  | ACRE  |
| Geotextile (Includes 10% overlapping factor) | 3,840 | SQ YD |

#### **Volume:**

|  |        |       |
|--|--------|-------|
| Overplacement and loss of armoring materials   | 20%    |       |
| West cell shoreline armoring area              | 31,363 | SQ FT |
| West cell volume (not including overplacement) | 2,330  | CY    |
| West cell volume (including overplacement)     | 2,800  | CY    |

#### **Weight:**

|   |       |        |
|---|-------|--------|
| Assumed unit weight of granular protection material | 1.65  | TON/CY |
| Tons of granular protection material                | 4,700 | TON    |

## **ALTERNATIVE 2 QUANTITIES**

### **Items 11 and 12 - Vegetated Area Repair**

#### **Key Assumptions:**

Disturbed areas will receive geotextile placement and granular cover.

|   |     |      |
|---|-----|------|
| Area disturbed by operations requiring repair | 0.5 | ACRE |
| Thickness of granular cover                   | 0.5 | FT   |

#### **Geotextile Area:**

|                |        |       |
|----------------|--------|-------|
| Disturbed area | 21,780 | SQ FT |
| Overplacement  | 10%    |       |
| Geotextile     | 23,958 | SQ FT |
| Geotextile     | 2,670  | SQ YD |

#### **Granular Cover:**

##### **Volume:**

|                                     |     |    |
|-------------------------------------|-----|----|
| Granular Cover                      | 403 | CY |
| Overplacement and loss of materials | 20% |    |
| Granular Cover                      | 490 | CY |

##### **Weight:**

|                     |     |         |
|---------------------|-----|---------|
| Assumed Unit Weight | 1.6 | TONS/CY |
| Total Weight        | 790 | TONS    |

### **Item 13 Hydraulic Dredging**

#### **Key Assumptions**

|                        |     |      |
|------------------------|-----|------|
| Dredge Area            | 1.2 | ACRE |
| Dredge cut depth       | 1.5 | FT   |
| Overdredging allowance | 0.5 | FT   |
| Dredge bulking factor  | 20% |      |

##### **Volume:**

|  |       |  |
|--|-------|--|
| Dredge volume (not including bulking factor) | 3,872 |  |
| Dredge volume                                | 4,700 |  |

### **Item 14 Geobag Dewatering**

#### **Key Assumptions**

|  |        |       |
|--|--------|-------|
| 900-Cubic yard geobag capacity               |        |       |
| Dewatering Area (Hand calculation)           | 50,772 | SF    |
| Thickness of Bedding Layer                   | 0.33   | FT    |
| Volume of Bedding Layer                      | 700    | CY    |
| Geotextile (Includes 10% overlapping factor) | 6,210  | SQ YD |

##### **# of Geotextile Tubes**

|                  |   |  |
|------------------|---|--|
| Geobags required | 6 |  |
|------------------|---|--|

### **ALTERNATIVE 3 QUANTITIES**

#### **Item 4 Perform Material Placement Surveys**

|  |   |
|--|---|
| Material placement surveys to verify material quantities | 3 |
|--|---|

#### **Item 5 Eastern Cell Granular Cover**

##### **Key Assumptions:**

|  |       |       |
|--|-------|-------|
| Layer thickness of granular material   | 0.5   | FT    |
| Overplacement Allowance  | 0.5   | FT    |
| Area of granular material placement  | 7.34  | ACRE  |
| Overplacement and loss of materials  | 20%   |       |
| Additional volume is required for deep water area to bring elevation to - 2 feet to construct remainder of cover |       |       |
| Original bottom of deep water area   | -9    | FT    |
| Top elev. of deep water area to begin layer  | -4    | FT    |
| Deep water area requiring additional fill  | 6,720 | SQ FT |

##### **Volume:**

|   |         |       |
|---|---------|-------|
| Area of granular material placement                             | 319,730 | SQ FT |
| Volume for thickened fill area prior to 0.5-ft cover            | 1,250   | CY    |
| Volume of granular material for 0.5-ft cover (no overplacement) | 5,930   | CY    |
| Volume of granular material (no overplacement)                  | 7,180   | CY    |
| Volume of granular material (including overplacement)           | 13,110  | CY    |

##### **Weight:**

|   |        |         |
|---|--------|---------|
| Assumed unit weight of granular protection material | 1.9    | TONS/CY |
| Tons of granular material                           | 25,000 | TONS    |

#### **Item 6 Eastern Cell Rock Cover**

##### **Key Assumptions:**

|  |       |       |
|--|-------|-------|
| Layer thickness of rock cover  | 2.0   | FT    |
| Area of rock material placement  | 1.1   | ACRE  |
| Additional volume is required for deep water area to bring elevation to - 2 feet to construct remainder of earth cover |       |       |
| Original bottom of deep water area   | -9    | FT    |
| Top elev. of deep water area to begin earthen layer  | -4    | FT    |
| Deep water area requiring additional fill  | 4,480 | SQ FT |
| Geotextile Layer (Includes 10% overlapping factor)   | 5,750 | SQ YD |

##### **Volume:**

|                              |       |    |
|------------------------------|-------|----|
| 2-foot cover volume          | 3,490 | CY |
| additional volume to -2 feet | 830   | CY |
| total cover volume           | 4,320 | CY |

##### **Weight:**

|  |       |        |
|--|-------|--------|
| Assumed unit weight of rock cover material | 1.65  | TON/CY |
| Tons of material:                          | 7,200 | TON    |

### **ALTERNATIVE 3 QUANTITIES**

#### **Item 7 Western Cell Berm**

##### Key Assumptions

|                          |     |    |
|--------------------------|-----|----|
| Exterior Slope (XH:1V)   | 3   |    |
| Interior Slope (XH:1V)   | 2   |    |
| Bottom of berm elevation | 0   | FT |
| Top of berm elevation    | 4   | FT |
| Width of berm at crest   | 8   | FT |
| Length of berm           | 350 | FT |

##### Volume:

|                             |     |       |
|-----------------------------|-----|-------|
| Berm Volume per linear foot | 72  | CU FT |
| Berm Volume                 | 933 | CY    |

##### Weight:

|                                 |       |        |
|---------------------------------|-------|--------|
| Assumed unit weight of material | 1.9   | TON/CY |
| Tons of material                | 1,800 | TON    |

#### **Item 8 Shoreline Armoring**

##### Key Assumptions

|  |       |       |
|--|-------|-------|
| Layer thickness                              | 2.0   | FT    |
| West cell shoreline armoring area            | 0.72  | ACRE  |
| Geotextile (Includes 10% overlapping factor) | 3,840 | SQ YD |

##### Volume:

|  |        |       |
|--|--------|-------|
| Overplacement and loss of materials            | 20%    |       |
| West cell shoreline armoring area              | 31,363 | SQ FT |
| West cell volume (not including overplacement) | 2,330  | CY    |
| West cell volume (including overplacement)     | 2,800  | CY    |

##### Weight:

|                                 |       |        |
|---------------------------------|-------|--------|
| Assumed unit weight of material | 1.65  | TON/CY |
| Tons of material                | 4,700 | TON    |

#### **Items 9 and 10 - Vegetated Area Repair**

##### Key Assumptions:

|   |     |      |
|---|-----|------|
| Disturbed areas will receive geotextile placement and granular cover. |     |      |
| Area disturbed by operations requiring repair                         | 0.5 | ACRE |
| Thickness of granular cover   | 0.5 | FT   |

##### Geotextile Area:

|  |        |       |
|--|--------|-------|
| Disturbed area                               | 21,780 | SQ FT |
| Overplacement                                | 10%    |       |
| Geotextile                                   | 23,958 | SQ FT |
| Geotextile (Includes 10% overlapping factor) | 2,670  | SQ YD |

##### Granular Cover:

##### Volume:

|                                     |     |    |
|-------------------------------------|-----|----|
| Granular Cover                      | 403 | CY |
| Overplacement and loss of materials | 20% |    |
| Granular Cover                      | 490 | CY |

##### Weight:

|                     |     |         |
|---------------------|-----|---------|
| Assumed Unit Weight | 1.6 | TONS/CY |
| Total Weight        | 790 | TONS    |

#### **Item 11 Northwestern Area Granular Cover**

##### Key Assumptions:

|                                   |     |      |
|-----------------------------------|-----|------|
| Layer thickness                   | 0.5 | FT   |
| Overplacement Allowance           | 0.5 | FT   |
| Northwestern rock cover area size | 1.2 | ACRE |

##### Volume:

|                              |       |    |
|------------------------------|-------|----|
| Northwestern rock cover area | 1,936 | CY |
|------------------------------|-------|----|

##### Weight:

|                                 |       |        |
|---------------------------------|-------|--------|
| Assumed unit weight of material | 1.7   | TON/CY |
| Tons of material:               | 3,300 | TON    |

#### **ALTERNATIVE 4 QUANTITIES**

##### **Item 4 Perform Material Placement Surveys**

|  |   |  |
|--|---|--|
| Material placement surveys to verify material quantities | 3 |  |
|--|---|--|

##### **Item 5 Eastern Cell Granular Cover**

###### **Key Assumptions:**

|                                      |      |      |
|--------------------------------------|------|------|
| Layer thickness of granular material | 0.5  | FT   |
| Overplacement Allowance              | 0.5  | FT   |
| Area of granular material placement  | 7.34 | ACRE |

###### **Volume:**

|   |         |       |
|---|---------|-------|
| Area of granular material placement                       | 319,730 | SQ FT |
| Volume of granular material (not including overplacement) | 5,930   | CY    |
| Volume of granular material (including overplacement)     | 11,850  | CY    |

###### **Weight:**

|   |        |         |
|---|--------|---------|
| Assumed unit weight of granular protection material | 1.9    | TONS/CY |
| Tons of granular material                           | 22,600 | TONS    |

##### **Item 6A TCRA Rock Berm**

###### **Key Assumptions**

|  |       |       |
|--|-------|-------|
| Exterior Slope (XH:1V)                       | 3     |       |
| Interior Slope (XH:1V)                       | 2     |       |
| Bottom of berm elevation                     | -4    | FT    |
| Top of berm elevation                        | 1     | FT    |
| Width of berm at crest                       | 8     | FT    |
| Length of berm                               | 1,550 | FT    |
| Geotextile (Includes 10% overlapping factor) | 6,260 | SQ YD |

###### **Volume:**

|                             |       |       |
|-----------------------------|-------|-------|
| Berm Volume per linear foot | 103   | CU FT |
| Berm Volume                 | 5,884 | CY    |

###### **Weight:**

|                                 |       |        |
|---------------------------------|-------|--------|
| Assumed unit weight of material | 1.65  | TON/CY |
| Tons of material                | 9,800 |        |

##### **Item 6B TCRA Rock Berm**

###### **Key Assumptions:**

Additional volume is required for deep water area to bring elevation to -4 feet to construct remainder of rock berm

|   |     |    |
|---|-----|----|
| Exterior Slope (XH:1V)                          | 3   |    |
| Interior Slope (XH:1V)                          | 2   |    |
| Original bottom of deep water area              | -9  | FT |
| Top elev. of deep water area to begin rock berm | -4  | FT |
| Length of deep water portion of berm            | 300 | FT |

###### **Volume:**

|  |       |       |
|--|-------|-------|
| Width of deep water portion of berm at crest | 33    | FT    |
| Deep water berm volume per linear foot       | 228   | CU FT |
| Deep water berm volume                       | 1,685 | CY    |

###### **Weight:**

|                                 |       |        |
|---------------------------------|-------|--------|
| Assumed unit weight of material | 1.65  | TON/CY |
| Tons of material                | 2,800 |        |



## **ALTERNATIVE 4 QUANTITIES**

### **Item 7 Western Cell Berm**

#### **Key Assumptions**

|                          |     |    |
|--------------------------|-----|----|
| Exterior Slope (XH:1V)   | 3   |    |
| Interior Slope (XH:1V)   | 2   |    |
| Bottom of berm elevation | 0   | FT |
| Top of berm elevation    | 4   | FT |
| Width of berm at crest   | 8   | FT |
| Length of berm           | 350 | FT |

#### **Volume:**

|                             |     |       |
|-----------------------------|-----|-------|
| Berm Volume per linear foot | 72  | CU FT |
| Berm Volume                 | 933 | CY    |

#### **Weight:**

|                                 |       |        |
|---------------------------------|-------|--------|
| Assumed unit weight of material | 1.9   | TON/CY |
| Tons of material                | 1,800 | TON    |

### **Item 8 Shoreline Armoring**

#### **Key Assumptions**

|  |       |       |
|--|-------|-------|
| Layer thickness                              | 2.0   | FT    |
| West cell shoreline armoring area            | 0.72  | ACRE  |
| Geotextile (Includes 10% overlapping factor) | 3,840 | SQ YD |

#### **Volume:**

|  |        |       |
|--|--------|-------|
| Overplacement and loss of materials            | 20%    |       |
| West cell shoreline armoring area              | 31,363 | SQ FT |
| West cell volume (not including overplacement) | 2,330  | CY    |
| West cell volume (including overplacement)     | 2,800  | CY    |

#### **Weight:**

|                                 |       |        |
|---------------------------------|-------|--------|
| Assumed unit weight of material | 1.65  | TON/CY |
| Tons of material                | 4,700 | TON    |

### **Items 9 and 10 - Vegetated Area Repair**

#### **Key Assumptions:**

|   |     |      |
|---|-----|------|
| Disturbed areas will receive geotextile placement and granular cover. |     |      |
| Area disturbed by operations requiring repair                         | 0.5 | ACRE |
| Thickness of granular cover   | 0.5 | FT   |

#### **Geotextile Area:**

|                |        |       |
|----------------|--------|-------|
| Disturbed area | 21,780 | SQ FT |
| Overplacement  | 10%    |       |
| Geotextile     | 23,958 | SQ FT |
| Geotextile     | 2,670  | SQ YD |

#### **Granular Cover:**

#### **Volume:**

|                                     |     |    |
|-------------------------------------|-----|----|
| Granular Cover                      | 403 | CY |
| Overplacement and loss of materials | 20% |    |
| Granular Cover                      | 490 | CY |

#### **Weight:**

|                     |     |         |
|---------------------|-----|---------|
| Assumed Unit Weight | 1.6 | TONS/CY |
| Total Weight        | 790 | TONS    |

### **Item 11 Northwestern Area Granular Cover**

#### **Key Assumptions:**

|                                   |     |      |
|-----------------------------------|-----|------|
| Layer thickness                   | 0.5 | FT   |
| Overplacement Allowance           | 0.5 | FT   |
| Northwestern rock cover area size | 1.2 | ACRE |

#### **Volume:**

|                              |       |    |
|------------------------------|-------|----|
| Northwestern rock cover area | 1,936 | CY |
|------------------------------|-------|----|

#### **Weight:**

|                                 |       |        |
|---------------------------------|-------|--------|
| Assumed unit weight of material | 1.7   | TON/CY |
| Tons of material:               | 3,300 | TON    |

## **ALTERNATIVE 5 QUANTITIES**

### **Item 4 Perform Material Placement Surveys**

|  |   |  |
|--|---|--|
| Material placement surveys to verify material quantities | 3 |  |
|--|---|--|

### **Item 5 ACBM Placement over Eastern Cell**

#### Key Assumptions:

|                       |     |      |
|-----------------------|-----|------|
| Area of ACBMplacement | 8.5 | ACRE |
|-----------------------|-----|------|

#### Volume:

|                        |         |       |
|------------------------|---------|-------|
| Area of ACBM placement | 369,400 | SQ FT |
|------------------------|---------|-------|

### **Item 6 Western Cell Berm**

#### Key Assumptions

|                          |     |    |
|--------------------------|-----|----|
| Exterior Slope (XH:1V)   | 3   |    |
| Interior Slope (XH:1V)   | 2   |    |
| Bottom of berm elevation | 0   | FT |
| Top of berm elevation    | 4   | FT |
| Width of berm at crest   | 8   | FT |
| Length of berm           | 350 | FT |

#### Volume:

|                             |     |       |
|-----------------------------|-----|-------|
| Berm Volume per linear foot | 72  | CU FT |
| Berm Volume                 | 933 | CY    |

#### Weight:

|                                 |       |        |
|---------------------------------|-------|--------|
| Assumed unit weight of material | 1.9   | TON/CY |
| Tons of material                | 1,800 | TON    |

### **Item 7 ACBM Shoreline Armoring - West Cell**

#### Key Assumptions:

|                       |     |      |
|-----------------------|-----|------|
| Area of ACBMplacement | 0.7 | ACRE |
|-----------------------|-----|------|

#### Volume:

|                        |        |       |
|------------------------|--------|-------|
| Area of ACBM placement | 31,400 | SQ FT |
|------------------------|--------|-------|

### **Items 8 and 9 - Vegetated Area Repair**

#### Key Assumptions:

|   |     |      |
|---|-----|------|
| Disturbed areas will receive geotextile placement and granular cover. |     |      |
| Area disturbed by operations requiring repair                         | 0.5 | ACRE |
| Thickness of granular cover   | 0.5 | FT   |

#### Geotextile Area:

|                |        |       |
|----------------|--------|-------|
| Disturbed area | 21,780 | SQ FT |
| Overplacement  | 10%    |       |
| Geotextile     | 23,958 | SQ FT |
| Geotextile     | 2,670  | SQ YD |

#### Granular Cover:

#### Volume:

|                                     |     |    |
|-------------------------------------|-----|----|
| Granular Cover                      | 403 | CY |
| Overplacement and loss of materials | 20% |    |
| Granular Cover                      | 490 | CY |

#### Weight:

|                     |     |         |
|---------------------|-----|---------|
| Assumed Unit Weight | 1.6 | TONS/CY |
| Total Weight        | 790 | TONS    |

## **ALTERNATIVE 5 QUANTITIES**

### **Item 10 Scour Protection**

#### **Key Assumptions:**

Assumes 15-foot wide scour protection apron at toe of ACBM

|                                     |       |    |
|-------------------------------------|-------|----|
| Layer thickness of scour protection | 3.0   | FT |
| Length of affected slope            | 1,854 | FT |
| Placement width                     | 15    | FT |

#### **Volume:**

|                          |       |    |
|--------------------------|-------|----|
| Area of scour protection | 3,090 | CY |
|--------------------------|-------|----|

#### **Weight:**

|  |       |         |
|--|-------|---------|
| Assumed unit weight of scour protection material | 1.65  | TONS/CY |
| Tons of scour protection material                | 5,100 | TONS    |

### **Item 11 Hydraulic Dredging**

#### **Key Assumptions**

|                        |     |      |
|------------------------|-----|------|
| Dredge Area            | 1.2 | ACRE |
| Dredge cut depth       | 1.5 | FT   |
| Overdredging allowance | 0.5 | FT   |
| Dredge bulking factor  | 20% |      |

#### **Volume:**

|  |       |  |
|--|-------|--|
| Dredge volume (not including bulking factor) | 3,872 |  |
| Dredge volume                                | 4,700 |  |

### **Item 12 Geobag Dewatering**

#### **Key Assumptions**

|  |        |       |
|--|--------|-------|
| 900-Cubic yard geobag capacity               |        |       |
| Dewatering Area (Hand calculation)           | 50,772 | SF    |
| Thickness of Bedding Layer                   | 0.33   | FT    |
| Volume of Bedding Layer                      | 700    | CY    |
| Geotextile (Includes 10% overlapping factor) | 6,210  | SQ YD |

#### **# of Geotextile Tubes**

|                  |   |  |
|------------------|---|--|
| Geobags required | 6 |  |
|------------------|---|--|

## **ALL ALTERNATIVES**

### **Item 2 Access Road Construction**

|                           |    |        |  |
|---------------------------|----|--------|--|
| Southern Crushed Concrete | \$ | 15.46  | per ton FOB job site; crushed road base  |
| Cherry Crushed Concrete   | \$ | 17.60  | per ton FOB job site; includes sales tax |
| Geotextile Fabric         |    | \$4.00 | SQ YD Mirafi 160N                        |

### **Item 3 Environmental Controls**

|   |                  |       |   |
|---|------------------|-------|---|
| Maritime Signage and Fishing Advisory Markers | \$15,000         | LS    |   |
| Reinforced Wire Fencing                       | \$55,000         | LS    |   |
| Silt Fencing                                  | 4,100            | LF    |   |
| Silt Fencing Unit Cost                        | \$2              | \$/LF | From locally available materials, installation costs from <i>RS Means Heavy Construction 2008</i> |
| Silt Fencing Total Cost                       | \$8,200          |       |   |
| Turbidity Curtain                             | 2,350            | LF    | Hand calculation  |
| Turbidity Curtain Unit Cost                   | \$40             | \$/LF | Based on as-built costs on a similar project  |
| Turbidity Curtain Total Cost                  | \$94,000         |       |   |
| <b>Total</b>                                  | <b>\$172,000</b> |       |   |

### **Non-Construction Items**

|                                     |           |
|-------------------------------------|-----------|
| Contingency                         | 30%       |
| Engineering Design                  | \$100,000 |
| Construction Management             | 8%        |
| Close Out & Documentation           | 0.50%     |
| Regulatory Compliance Documentation | \$45,000  |
| Environmental Monitoring - Sampling | \$25,000  |

## **ALTERNATIVE 1**

### **Item 1 Mobilization/Demobilization**

#### **Key Assumptions:**

|   |           |   |
|---|-----------|---|
| Sheet pile equipment mob/demob costs:                       | \$65,000  | personal communication, Mark Coyle of Orion Construction, 5-18-2010     |
| Allowance to improve boat slip at SE corner of project site | \$50,000  |   |
| Remaining construction mob/demob costs:                     | \$210,000 | 10 percent of construction costs, not including steel pile installation |

Mobilization/Demobilization Total: \$325,000

|                   |          |  |
|-------------------|----------|--|
| Health and Safety | \$69,000 | Assumes one employee working half-time for duration of project, rate of \$110/hr, plus initial development costs |
| Quality Control   | \$69,000 | Assumes one employee working half-time for duration of project, rate of \$110/hr, plus initial development costs |

### **Item 4 Surveying**

Progress Survey \$4,000 EA.

### **Item 5 Rock Platform**

Rock Protection in NW Boundary \$28.00 TON 3' x 5" Bull Rock quote from Cherry Crushed Concrete, \$20.80 per ton, 1.7 tons/cy  
Add \$2 to back dump in place along road way with trucks or belay using front end loader

### **Item 6 Sheetpile Wall**

#### **Material Cost**

Vinyl Sheetpile Unit Cost (\$/SF): \$8.50 personal communication, Vito Phelan of Crane Materials International, 5-21-2010 (see Material Prices tab)

#### **Installation Cost**

|  |         |   |
|--|---------|---|
| Personnel/Equipmt./Consumables per day:      | \$8,500 | personal communication, Mark Coyle of Orion Construction, 5-18-2010 |
| Shallow water (LF/day)                       | 40.0    |   |
| Deep water (LF/day)                          | 30.0    |   |
| Installation rate, weighted average (SF/day) | 1,280   |   |
| Installation Cost (\$/SF)                    | \$6.60  |   |

Total Cost (\$/SF): \$16  
Days Required 57

**Item 7 Scour Protection**

|   |         |     |   |
|---|---------|-----|---|
| Inner Wall - Processed concrete bull rock | \$29.00 | TON | 3" x 5" Bull Rock quote from Cherry Crushed Concrete, \$20.80 per ton, 1.7 tons/cy - deep water placement |
| Outer Wall - Natural Rock                 | \$70.00 | TON | Large limestone or granite rock barged to site  |

**Item 8 Eastern Cell Granular Cover**

|                     |         |     |  |
|---------------------|---------|-----|--|
| Granular Cover Cost | \$29.00 | TON | Sand and gravel mix: 5 parts bank sand, 5 parts processed concrete, and 1 part large limestone rock. |
|---------------------|---------|-----|--|

**Item 9 Western Cell Cover**

|                                    |         |       |   |
|------------------------------------|---------|-------|---|
| Processed Concrete Bull Rock       | \$28.00 | TON   | 3" x 5" Bull Rock quote from Cherry Crushed Concrete, \$20.80 per ton, 1.7 tons/cy  |
| Western Cell Granular Cover        | \$26.00 | TON   | Processed Concrete quote from Cherry Crushed Concrete, \$17.60 per ton, 1.9 tons/cy |
| Western Cell Gran Cover Geotextile | \$5.00  | SQ YD | Mirafi 1120N  |
| Geotextile Fabric                  | \$4.00  | SQ YD | Mirafi 160N   |
| Granular Cover Cost                | \$29.00 | TON   |   |

**Item 16 OM&M**Key Assumptions:

|  |    |  |
|--|----|--|
| One cap maintenance repair event of 5% of original cap volumes in Year 3 |    |  |
| Bathymetric survey annually for 7 years                                  |    |  |
| Interest Rate  | 5% |  |

|                                       |           |  |
|---------------------------------------|-----------|--|
| Total Cost of Placed Cap (\$)         | \$845,000 | includes east cell granular cover, west cell granular cover, and west cell rock protection |
| Anticipated Cap Repairs (% of Placed) | 5%        |  |
| LTM for Cap (\$ NPV)                  | \$37,000  |  |

|                         |          |  |
|-------------------------|----------|--|
| Bathymetric Survey (\$) | \$4,000  | Verbal quote from Rob Roman of Hydrographic Technologies |
| LTM for Survey (\$ NPV) | \$24,000 | annual survey in years 1-7                               |

|            |          |  |
|------------|----------|--|
| Total OM&M | \$61,000 |  |
|------------|----------|--|

## **ALTERNATIVE 2**

### **Item 1 - Mobilization/Demobilization**

#### **Key Assumptions:**

|   |           |  |
|---|-----------|--|
| Sheet pile equipment mob/demob costs:                       | \$65,000  | personal communication, Mark Coyle of Orion Construction, 5-18-2010  |
| Allowance to improve boat slip at SE corner of project site | \$50,000  |  |
| Hydraulic dredging  | \$65,000  | dredge mobilization/demobilization (\$50K) based on locally available dredges (<25 miles) + and appr. 1,500 LF of pipeline (\$15K) |
| Remaining construction mob/demob costs:                     | \$210,000 | 10 percent of construction costs, not including hydraulic dredging and steel pile installation                                     |

Mobilization/Demobilization Total: \$390,000

|                   |          |  |
|-------------------|----------|--|
| Health and Safety | \$56,000 | Assumes one employee working half-time for duration of project, rate of \$110/hr, plus initial development costs |
| Quality Control   | \$56,000 | Assumes one employee working half-time for duration of project, rate of \$110/hr, plus initial development costs |

### **Item 4 Surveying**

Progress Survey \$4,000 EA.

### **Item 5 Rock Platform**

Rock Protection in NW Boundary \$28.00 TON 3" x 5" Bull Rock quote from Cherry Crushed Concrete, \$20.80 per ton, 1.7 tons/cy  
Add \$2 to back dump in place along road way with trucks or belay using front end loader

### **Item 6 Sheetpile Wall**

#### **Material Cost**

Vinyl Sheetpile Unit Cost (\$/SF): \$8.50 personal communication, Vito Phelan of Crane Materials International, 5-21-2010 (see Material Prices tab)

#### **Installation Cost**

|  |         |   |
|--|---------|---|
| Personnel/Equipmt./Consumables per day       | \$8,500 | personal communication, Mark Coyle of Orion Construction, 5-18-2010 |
| Shallow water (LF/day)                       | 40.0    | personal communication, Mark Coyle of Orion Construction, 5-18-2010 |
| Deep water (LF/day)                          | 30.0    | personal communication, Mark Coyle of Orion Construction, 5-18-2010 |
| Installation rate, weighted average (SF/day) | 1,070   |   |
| Installation Cost (\$/SF)                    | \$7.90  |   |

Total Cost (\$/SF): \$17  
Days Required 39



**Item 7 Scour Protection**

|  |         |     |   |
|--|---------|-----|---|
| Inner Wall - Processed concrete bull rock    | \$29.00 | TON | 3" x 5" Bull Rock quote from Cherry Crushed Concrete, \$20.80 per ton, 1.7 tons/cy - deep water placement |
| Outer Wall - Large limestone or granite rock | \$70.00 | TON | Large limestone or granite rock barged to site - deep water placement                                     |

**Item 8 Eastern Cell Granular Cover**

|                     |         |     |  |
|---------------------|---------|-----|--|
| Granular Cover Cost | \$29.00 | TON | Sand and gravel mix: 5 parts bank sand, 5 parts processed concrete, and 1 part large limestone rock. |
|---------------------|---------|-----|--|

**Item 9 Western Cell Cover**

|                              |         |     |  |
|------------------------------|---------|-----|--|
| Processed Concrete Bull Rock | \$28.00 | TON | 3" x 5" Bull Rock quote from Cherry Crushed Concrete, \$20.80 per ton, 1.7 tons/cy |
|------------------------------|---------|-----|--|

**Item 10 Shoreline Armoring**

|              |         |       |  |
|--------------|---------|-------|--|
| Natural Rock | \$68.00 | TON   | Large limestone or granite rock barged to site |
| Geotextile   | \$5.00  | SQ YD | Mirafi 1120N                                   |

**Item 11 Vegetated Area Repair - Geotextile**

|                   |        |       |             |
|-------------------|--------|-------|-------------|
| Geotextile Fabric | \$4.00 | SQ YD | Mirafi 160N |
|-------------------|--------|-------|-------------|

**Item 12 Vegetated Area Repair - Granular Cover**

|                     |         |     |  |
|---------------------|---------|-----|--|
| Granular Cover Cost | \$29.00 | TON |  |
|---------------------|---------|-----|--|

### Item 13 Dredging

#### Information for this item obtained from:

Phone Call with David Guillot

Phone Call with Tony Cazalas

T.W Laquay Dredging 361-552-2010

C&C Marine 251-232-8587

\$2500 a day for ownership cost for dredge, pipe and small boat

Run 24/7 to get the job done

3-4 guys on the night crew

5-6 guys on the day crew

400 HP main engine driving pump and hydraulics

Swinging Ladder Dredge

Fuel for dredge, small boats etc \$2500 / day

150 cy/hr in material

Make a 3 ft set every 1.2 min/ 50 min per hour

Clean pump 2 hrs for every 24 hours of operation

Operators \$20.00

Laborers \$15.00

PerDiem \$50.00

Fuel Cost \$2.25 per gal

Both indicated 24/7 operations, maybe one day a week off.

#### Ownership Operations

|                    | No. | Hours/Day          | Rate    | Total           |
|--------------------|-----|--------------------|---------|-----------------|
| Ownership          | 1   |                    | \$2,500 |                 |
| <u>Operations:</u> |     |                    |         |                 |
| Fuel               | 1   |                    | \$2,916 | \$2,916         |
| Operators          | 2   | 8                  | \$20    | \$320           |
| Ops OT             | 2   | 4                  | \$30    | \$240           |
| Laborers           | 6   | 12                 | \$15    | \$1,080         |
| Labor OT           | 6   | 4                  | \$23    | \$540           |
| Super              | 1   | 8                  | \$30    | \$240           |
| Clerk              | 1   | 8                  | \$10    | \$80            |
| Per Diem           | 9   | 1                  | \$125   | \$1,125         |
|                    |     |                    |         | <b>\$3,625</b>  |
|                    |     | Labor w/ Fringes   | 42%     | \$5,148         |
|                    |     | Day Rate w/ OH     | 22%     | \$12,887        |
|                    |     | Day Rate w/ Profit | 9.40%   | <b>\$14,099</b> |

| hr/day | cy/hr | gross % | cy/day | \$/day   | unit price |
|--------|-------|---------|--------|----------|------------|
| 18     | 150   | 20%     | 2,160  | \$ 5,148 | \$ 2.38    |

|                  |            |               |
|------------------|------------|---------------|
| Hrs Uptime/day   | 18         | HR            |
| Dredge rate      | 150        | CY/HR         |
| Gross %          | 20%        |               |
| Dredge rate      | 2,160      | CY/DAY        |
| Day rate         | \$14,099   |               |
| <b>Unit rate</b> | <b>\$7</b> | <b>PER CY</b> |

**Item 14 Geobag Dewatering**

Geobag Capacity (cy):

HDPE Pipeline (\$/lf):

HDPE Pipeline (lf):

Purchase and Setup:

Maintenance:

Geotextile Layer (\$/sq yd):

|          |             |
|----------|-------------|
| 900      |             |
| \$10     |             |
| 1500     |             |
| \$16,500 | per bag     |
| \$2,000  | per bag     |
| \$4.00   | Mirafi 160N |

**Item 21 OM&M**Key Assumptions:

One cap maintenance repair event of 5% of original cap volumes in Year 3

Bathymetric survey annually for 7 years

Interest Rate 5%

Total Cost of Placed Cap (\$)

\$1,001,000 includes east cell granular cover, west cell berm, and west cell armoring

Anticipated Cap Repairs (% of Placed)

5%

LTM for Cap (\$ NPV)

\$44,000

Bathymetric Survey (\$)

\$4,000 Verbal quote from Rob Roman of Hydrographic Technologies

LTM for Survey (\$ NPV)

\$24,000 annual survey in years 1-7

Total OM&amp;M

\$68,000

### **ALTERNATIVE 3**

#### **Item 1 - Mobilization/Demobilization**

##### Key Assumptions:

|   |           |                                  |
|---|-----------|----------------------------------|
| Allowance to improve boat slip at SE corner of project site | \$50,000  |                                  |
| Remaining construction mob/demob costs:                     | \$200,000 | 10 percent of construction costs |

|                                    |           |  |
|------------------------------------|-----------|--|
| Mobilization/Demobilization Total: | \$250,000 |  |
|------------------------------------|-----------|--|

|                   |          |  |
|-------------------|----------|--|
| Health and Safety | \$32,000 | Assumes one employee working half-time for duration of project, rate of \$110/hr, plus initial development costs |
| Quality Control   | \$32,000 | Assumes one employee working half-time for duration of project, rate of \$110/hr, plus initial development costs |

#### **Item 4 Surveying**

|                 |         |     |
|-----------------|---------|-----|
| Progress Survey | \$4,000 | EA. |
|-----------------|---------|-----|

#### **Item 5 Granular Cover**

|                     |         |     |  |
|---------------------|---------|-----|--|
| Granular Cover Cost | \$29.00 | TON | Sand and gravel mix: 5 parts bank sand, 5 parts processed concrete, and 1 part large limestone rock. |
|---------------------|---------|-----|--|

#### **Item 6 Rock Cover**

|              |         |       |  |
|--------------|---------|-------|--|
| Natural Rock | \$68.00 | TON   | Large limestone or granite rock barged to site |
| Geotextile   | \$5.00  | SQ YD | Mirafi 1120N                                   |

#### **Item 7 Western Cell Berm**

|                              |         |     |  |
|------------------------------|---------|-----|--|
| Processed Concrete Bull Rock | \$28.00 | TON | 3" x 5" Bull Rock quote from Cherry Crushed Concrete, \$20.80 per ton, 1.7 tons/cy |
|------------------------------|---------|-----|--|

#### **Item 8 Shoreline Armoring**

|              |         |       |  |
|--------------|---------|-------|--|
| Natural Rock | \$68.00 | TON   | Large limestone or granite rock barged to site |
| Geotextile   | \$5.00  | SQ YD | Mirafi 1120N                                   |

#### **Item 9 Vegetated Area Repair - Geotextile**

|                   |        |       |             |
|-------------------|--------|-------|-------------|
| Geotextile Fabric | \$4.00 | SQ YD | Mirafi 160N |
|-------------------|--------|-------|-------------|

#### **Item 10 Vegetated Area Repair - Granular Cover**

|                     |         |     |  |
|---------------------|---------|-----|--|
| Granular Cover Cost | \$29.00 | TON |  |
|---------------------|---------|-----|--|

#### **Item 11 Northwestern Area**

|                     |         |     |  |
|---------------------|---------|-----|--|
| Granular Cover Cost | \$29.00 | TON | Sand and gravel mix: 5 parts bank sand, 5 parts processed concrete, and 1 part large limestone rock. |
|---------------------|---------|-----|--|

#### **Item 18 OM&M**

##### Key Assumptions:

|  |    |
|--|----|
| One cap maintenance repair event of 5% of original cap volumes in Year 3 |    |
| Bathymetric survey annually for 7 years                                  |    |
| Interest Rate  | 5% |

|                                       |             |   |
|---------------------------------------|-------------|---|
| Total Cost of Placed Cap (\$)         | \$1,682,000 | includes east cell granular cover, east cell rock cover, west cell berm, west cell armoring, and NW area rock cover |
| Anticipated Cap Repairs (% of Placed) | 5%          |   |
| LTM for Cap (\$ NPV)                  | \$73,000    |   |

|                         |          |  |
|-------------------------|----------|--|
| Bathymetric Survey (\$) | \$4,000  | Verbal quote from Rob Roman of Hydrographic Technologies |
| LTM for Survey (\$ NPV) | \$24,000 | annual survey in years 1-7                               |

|            |          |  |
|------------|----------|--|
| Total OM&M | \$97,000 |  |
|------------|----------|--|

#### **ALTERNATIVE 4**

##### **Item 1 - Mobilization/Demobilization**

###### **Key Assumptions:**

|   |           |                                  |
|---|-----------|----------------------------------|
| Allowance to improve boat slip at SE corner of project site | \$50,000  |                                  |
| Remaining construction mob/demob costs:                     | \$230,000 | 10 percent of construction costs |

|                                    |           |  |
|------------------------------------|-----------|--|
| Mobilization/Demobilization Total: | \$280,000 |  |
|------------------------------------|-----------|--|

|                   |          |  |
|-------------------|----------|--|
| Health and Safety | \$31,000 | Assumes one employee working half-time for duration of project, rate of \$110/hr, plus initial development costs |
| Quality Control   | \$31,000 | Assumes one employee working half-time for duration of project, rate of \$110/hr, plus initial development costs |

##### **Item 4 Surveying**

|                 |         |     |
|-----------------|---------|-----|
| Progress Survey | \$4,000 | EA. |
|-----------------|---------|-----|

##### **Item 5 Granular Cover**

|                     |         |     |  |
|---------------------|---------|-----|--|
| Granular Cover Cost | \$29.00 | TON | Sand and gravel mix: 5 parts bank sand, 5 parts processed concrete, and 1 part large limestone rock. |
|---------------------|---------|-----|--|

##### **Item 6 TCRA Rock Berm**

|              |         |       |  |
|--------------|---------|-------|--|
| Natural Rock | \$68.00 | TON   | Large limestone or granite rock barged to site |
| Geotextile   | \$5.00  | SQ YD | Mirafi 1120N                                   |

##### **Item 7 Western Cell Berm**

|                              |         |     |  |
|------------------------------|---------|-----|--|
| Processed Concrete Bull Rock | \$28.00 | TON | 3" x 5" Bull Rock quote from Cherry Crushed Concrete, \$20.80 per ton, 1.7 tons/cy<br>Add \$2 to back dump in place along road way with trucks or belay using front end loader |
|------------------------------|---------|-----|--|

##### **Item 8 Shoreline Armoring**

|              |         |       |  |
|--------------|---------|-------|--|
| Natural Rock | \$68.00 | TON   | Large limestone or granite rock barged to site |
| Geotextile   | \$5.00  | SQ YD | Mirafi 1120N                                   |

##### **Item 9 Vegetated Area Repair - Geotextile**

|                   |        |       |             |
|-------------------|--------|-------|-------------|
| Geotextile Fabric | \$4.00 | SQ YD | Mirafi 160N |
|-------------------|--------|-------|-------------|

##### **Item 10 Vegetated Area Repair - Granular Cover**

|                     |         |     |  |
|---------------------|---------|-----|--|
| Granular Cover Cost | \$29.00 | TON |  |
|---------------------|---------|-----|--|

##### **Item 11 Northwestern Area**

|                     |         |     |  |
|---------------------|---------|-----|--|
| Granular Cover Cost | \$29.00 | TON | Sand and gravel mix: 5 parts bank sand, 5 parts processed concrete, and 1 part large limestone rock. |
|---------------------|---------|-----|--|

##### **Item 18 OM&M**

###### **Key Assumptions:**

|  |    |
|--|----|
| One cap maintenance repair event of 5% of original cap volumes in Year 3 |    |
| Bathymetric survey annually for 7 years                                  |    |
| Interest Rate  | 5% |

|                                       |             |   |
|---------------------------------------|-------------|---|
| Total Cost of Placed Cap (\$)         | \$1,980,000 | includes east cell granular cover, TCRA rock berm, west cell berm, west cell armoring, and NW area rock cover |
| Anticipated Cap Repairs (% of Placed) | 5%          |   |
| LTM for Cap (\$ NPV)                  | \$86,000    |   |

|                         |          |  |
|-------------------------|----------|--|
| Bathymetric Survey (\$) | \$4,000  | Verbal quote from Rob Roman of Hydrographic Technologies |
| LTM for Survey (\$ NPV) | \$24,000 | annual survey in years 1-7                               |

|            |           |  |
|------------|-----------|--|
| Total OM&M | \$110,000 |  |
|------------|-----------|--|

## **ALTERNATIVE 5**

### **Item 1 - Mobilization/Demobilization**

#### **Key Assumptions:**

|   |           |  |  |
|---|-----------|--|--|
| Allowance to improve boat slip at SE corner of project site | \$50,000  |  |  |
| Hydraulic dredging  | \$65,000  | dredge mobilization/demobilization (\$50K) based on locally available dredges (<25 miles) + and appr. 1,500 LF of pipeline (\$15K) |  |
| Remaining construction mob/demob costs:                     | \$410,000 | 10 percent of construction costs, not including hydraulic dredging   |  |
| Scour protection  | \$50,000  | mobilize barge to perform scour protection placement based on locally available equipment  |  |

Mobilization/Demobilization Total: \$575,000

|                   |          |  |
|-------------------|----------|--|
| Health and Safety | \$31,000 | Assumes one employee working half-time for duration of project, rate of \$110/hr, plus initial development costs |
| Quality Control   | \$31,000 | Assumes one employee working half-time for duration of project, rate of \$110/hr, plus initial development costs |

### **Item 4 Surveying**

Progress Survey \$4,000 EA.

### **Item 5 ACBM Placement over Eastern Cell**

ACBM Purchase & Placement \$8.00 SF From 1/11/2010 AQ estimate by W. Mears

### **Item 6 Western Cell Berm**

Processed Concrete Bull Rock \$28.00 TON 3" x 5" Bull Rock quote from Cherry Crushed Concrete, \$20.80 per ton, 1.7 tons/cy  
Add \$2 to back dump in place along road way with trucks or belay using front end loader

### **Item 7 ACBM Shoreline Armoring - West Cell**

ACBM Purchase & Placement \$8.00 SF From 1/11/2010 AQ estimate by W. Mears

### **Item 8 Vegetated Area Repair - Geotextile**

Geotextile Fabric \$4.00 SQ YD Mirafi 160N

### **Item 9 Vegetated Area Repair - Granular Cover**

Granular Cover Cost \$29.00 TON

### **Item 10 Scour Protection Apron**

Natural Rock \$70.00 TON Large limestone or granite rock barged to site

### **Item 11 Hydraulic Dredging**

Consult unit pricing for Alternative 2, Item 11

### **Item 12 Geobag Dewatering**

Consult unit pricing for Alternative 2, Item 12  
Geotextile \$4.00 SQ YD Mirafi 160N

### **Item 19 OM&M**

#### **Key Assumptions:**

One cap maintenance repair event of 5% of original cap volumes in Year 3

Bathymetric survey annually for 7 years

Interest Rate 5%

Total Cost of Placed Cap (\$) \$3,616,000 includes ACBM (east and west), west cell berm, and scour apron  
Anticipated Cap Repairs (% of Placed) 5%  
LTM for Cap (\$ NPV) \$157,000

Bathymetric Survey (\$) \$4,000 Verbal quote from Rob Roman of Hydrographic Technologies  
LTM for Survey (\$ NPV) \$24,000 annual survey in years 1-7

Total OM&M \$181,000

## **Materials**

### **Natural Rock**

Gradation: 600 lb. mix - D<sub>85</sub> = 600 lb stone  
Source: Phone conversation with Bill Shaw of Luhr Brothers (5-21-2010)  
Material Cost: - TON  
Installation Cost: - TON  
Total Cost: \$68.00 TON shallow water placement - (Includes delivery, offload and placement costs)  
Total Cost: \$70.00 TON deep water placement - (Includes delivery, offload and placement costs)  
Unit Weight: 1.65 TON/CY  
Notes: Large limestone or granite rock barged to site

### **3" x 5" Bull Rock**

Gradation: 3" x 5"  
Source: Quote from Cherry Crushed Concrete, \$20.80 per ton, 1.7 tons/cy  
Material Cost: \$20.80 TON  
Installation Cost: \$6.40 TON shallow water placement - from *RS Means Heavy Construction 2008*, 1.5 min cycle, 3 cy bucket  
Installation Cost: \$7.90 TON deep water placement - from *RS Means Heavy Construction 2008*, 3 min cycle, 3 cy bucket  
Total Cost: \$28.00 TON shallow water placement  
Total Cost: \$29.00 TON deep water placement - Rock buttress in Alts 1 & 2, NW area of Alt 3 & 4,

Unit Weight: 1.7 TON/CY  
Notes: Used for scour protection and rock protection in NW boundary.  
For access roads, end dump the access roads from south to north. Use excavator to side cast material in both east and west directions, digging away the access road as he returns to shore.  
Add \$2 to back dump in place along road way with trucks or belay using front end loader

### **Processed Concrete**

Gradation: TXDOT Item 247  
Source: Quote from Cherry Crushed Concrete, \$17.60 per ton, 1.9 tons/cy  
Material Cost: \$17.60 TON  
Installation Cost: \$6.40 TON  
Total Cost: \$24.00 TON  
Unit Weight: 1.9 TON/CY  
Notes: Used for rock cover, processed concrete layer base, or western cell shoreline armor.

### **Sand Cover**

Gradation: ASTM C 136 - 35.3% retained on #50 Sieve, 96.4% retained on #200 Sieve - Gradation from Mega Sand  
Source: Quote from Mega Sand, 7.25 per cy delivered to the site.  
Material Cost: \$7.25 CY  
Installation Cost: \$6.40 CY  
Total Cost: \$14.00 CY  
Unit Weight: 1.2 TON/CY  
Notes: Used as a portion of the sand/gravel mix below.

### **Sand/Gravel Mix**

Gradation: N/A  
Source: N/A  
Material Cost: \$22.00 TON  
Installation Cost: \$6.40 TON  
Total Cost: \$29.00 TON  
Unit Weight: 1.6 TON/CY  
Notes: Mix of 5 parts bank sand, 5 parts processed concrete, and 1 part large limestone rock.  
Add \$2.00/ton end dump cost and \$4.53/ton placement cost to arrive at final in-place cost.

### **Rip Rap**

Gradation: Grade I Riprap (12" x 18")  
Source: Quote from Cherry Crushed Concrete, \$29.30 per ton, 1.4 tons/cy  
Material Cost: \$29.30 TON  
Installation Cost: \$6.40 TON  
Total Cost: \$36.00 TON  
Unit Weight: 1.4 TON/CY  
Notes: N/A

### **Other:**

|                        |               |  |
|------------------------|---------------|--|
| <b>Mirafi 160N</b>     | \$4.00 SQ YD  | Engineer's estimate from Scott Dull of Tencate (919.740.9989) on 5-25-2010   |
| <b>Mirafi 1120N</b>    | \$5.00 SQ YD  | Engineer's estimate from Scott Dull of Tencate (919.740.9989) on 5-25-2010   |
| <b>ACBM</b>            | \$8.00 SQ FT  | From 1/11/2010 AQ estimate by W. Mears<br>Quotation from Vito Phelan, Crane Materials International, 5-21-2010.<br>\$7.23/sq. ft. for SG625 sheet piling. Added 15% for contractor markup and rounded to \$8.50/sq.ft. |
| <b>Vinyl Sheetpile</b> | \$8.50 SQ FT  | Quotation from Chris Hughes of Skyline Steel (281.992.4000) on 5-25-2010   |
| <b>Steel Sheetpile</b> | \$23.00 SQ FT | for AZ19-700 series sheet pile. Added 15% for contractor markup  |



|                                  | OPTION 1 | OPTION 2 | OPTION 3 | OPTION 4 | OPTION 5 |
|----------------------------------|----------|----------|----------|----------|----------|
| MOB/DEMOB                        | 8        | 8        | 8        | 8        | 8        |
| GRANULAR COVER RATE (TONS/DAY)   | 920      | 920      | 920      | 920      | -        |
| GRANULAR COVER QUANT             | 28,300   | 21,700   | 25,000   | 22,600   | -        |
| GRANULAR COVER DAYS              | 31       | 24       | 28       | 25       | 0        |
| ROCK COVER RATE (TONS/DAY)       | 890      | -        | 890      | 890      | -        |
| ROCK COVER QUANT (TONS)          | 990      | -        | 10,500   | 3,300    | -        |
| ROCK COVER DAYS                  | 2        | 0        | 12       | 4        | 0        |
| CLAY COVER RATE (CY/DAY)         | -        | -        | 520      | -        | -        |
| CLAY COVER QUANT (CY)            | -        | -        | 7,200    | -        | -        |
| CLAY COVER DAYS                  | 0        | 0        | 14       | 0        | 0        |
| ROCK BERM RATE (TONS/DAY)        | -        | -        | -        | 550      | -        |
| ROCK BERM QUANT (TONS)           | -        | -        | -        | 12,600   | -        |
| ROCK BERM RATE DAYS              | 0        | 0        | 0        | 23       | 0        |
| WEST CELL BERM RATE (TONS/DAY)   | -        | 550      | 550      | 550      | 550      |
| WEST CELL BERM QUANT (TONS)      | -        | 1,800    | 1,800    | 1,800    | 1,800    |
| WEST CELL BERM RATE DAYS         | 0        | 4        | 4        | 4        | 4        |
| HYDRAULIC DREDGING RATE (CY/DAY) | -        | 2,160    | -        | -        | 2,160    |
| HYDRAULIC DREDGING QUANT (CY)    | -        | 4,700    | -        | -        | 4,700    |
| HYDRAULIC DREDGING DAYS          | 0        | 3        | 0        | 0        | 3        |
| GEOBAG SET UP DAYS               | 0        | 4        | 0        | 0        | 4        |
| ROCK PLATFORM RATE (TONS/DAY)    | 550      | 550      | -        | -        | -        |
| ROCK PLATFORM QUANT (TONS)       | 15,900   | 14,600   | -        | -        | -        |
| ROCK PLATFORM RATE DAYS          | 29       | 27       | 0        | 0        | 0        |
| SHEETPILE INSTALL RATE (LF/DAY)  | 35       | 35       | -        | -        | -        |
| SHEETPILE INSTALL QUANT (LF)     | 2,000    | 1,450    | -        | -        | -        |
| SHEETPILE INSTALL DAYS           | 58       | 42       | 0        | 0        | 0        |
| SCOUR PROTECTION RATE (LF/DAY)   | -        | -        | -        | -        | 550      |
| SCOUR PROTECTION QUANT (LF)      | -        | -        | -        | -        | 5,100    |
| SCOUR PROTECTION DAYS            | 0        | 0        | 0        | 0        | 10       |
| ROCK BUTTRESS RATE (TON/DAY)     | 500      | 500      | 0        | 0        | 0        |
| ROCK BUTTRESS QUANT (TON)        | 10,050   | 4,020    | 0        | 0        | 0        |
| ROCK BUTTRESS DAYS               | 21       | 9        | 0        | 0        | 0        |
| ACBM INSTALL RATE (SF/DAY)       | -        | -        | -        | -        | 12,000   |
| ACBM INSTALL QUANT (SF)          | -        | -        | -        | -        | 400,800  |
| ACBM INSTALL DAYS                | 0        | 0        | 0        | 0        | 34       |
| TOTAL DAYS                       | 149      | 121      | 66       | 64       | 63       |
| MONTHS                           | 6.08     | 4.94     | 2.69     | 2.61     | 2.57     |

## APPENDIX D

# DRAFT – ADCP AND BATHYMETRIC DATA SAMPLING AND ANALYSIS PLAN

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# DRAFT – ADCP AND BATHYMETRIC DATA SAMPLING AND ANALYSIS PLAN SAN JACINTO RIVER WASTE PITS SUPERFUND SITE

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**Prepared for**

U.S. Environmental Protection Agency, Region 6

**On behalf of**

McGinnes Industrial Maintenance Corporation

And

International Paper Company

**Prepared by**

Anchor QEA, LLC

614 Magnolia Avenue

Ocean Springs, Mississippi 39564

**May 2010**

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## List of Attachments

Attachment A    Datasheet for Teledyne Workhorse ADCP

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## LIST OF ACRONYMS AND ABBREVIATIONS

|       |   |
|-------|---|
| ADCP  | acoustic Doppler current profiler               |
| cfs   | cubic feet per second                           |
| CTD   | conductivity, temperature, and depth            |
| DQOs  | data quality objectives                         |
| EFDC  | Environmental Fluid Dynamics Code               |
| IPC   | International Paper Company                     |
| MIMC  | McGinnes Industrial Maintenance Corporation     |
| NOAA  | National Oceanic and Atmospheric Administration |
| QAPP  | Quality Assurance Project Plan                  |
| RAWP  | Removal Action Work Plan                        |
| RI/FS | Remedial Investigation/Feasibility Study        |
| SAP   | Sampling and Analysis Plan                      |
| Site  | San Jacinto River Waste Pits Superfund Site     |
| TCRA  | Time Critical Removal Action                    |
| USACE | U.S. Army Corps of Engineers                    |
| USEPA | U.S. Environmental Protection Agency            |
| USGS  | U.S. Geologic Survey                            |

---

## 1 INTRODUCTION

This Sampling and Analysis Plan (SAP) to support site-specific river current and bathymetric data collection for the San Jacinto River Waste Pits Superfund Site (the Site) was prepared on behalf of International Paper Company (IPC) and McGinnes Industrial Maintenance Corporation (MIMC; collectively referred to as the Respondents). Figure 1 presents a vicinity map of the Site.

This SAP is an appendix to the Time Critical Removal Action (TCRA) Alternatives Analysis for the Site. This plan is a companion plan to the Remedial Investigation/Feasibility Study (RI/FS) Work Plan (Anchor QEA and Integral 2010) and references that document where appropriate. The text in this plan is abstracted from a SAP Addendum submitted to the U.S. Environmental Protection Agency (USEPA) for a chemical and fate and transport modeling study (Anchor QEA 2010) at the Site.

### 1.1 Purpose

The river current and bathymetry data collection will be undertaken to address the following objectives:

- Collect Site-specific river current data in the vicinity of the Site using an acoustic Doppler current profiler (ADCP). This data will be used to refine the hydrodynamic model near the Site. The hydrodynamic model will be used to develop Site-specific design criteria for the TCRA design.
- Update and improve the data density for the river bottom contours by collecting additional bathymetric survey information around the Site. This information will be used to update the hydrodynamic model and to prepare detailed design plans to be included with the TRCA Removal Action Work Plan (RAWP).

### 1.2 Work Plan Organization

Section 1 of this SAP presents an introduction and brief overview of the project, while Section 2 describes the problem addressed by this plan. The modeling framework and approach is presented in Section 3. Data gaps and data quality objectives (DQOs) for the modeling study are described in Section 4. Field studies to be conducted in support of the



modeling analyses are presented in Section 5. The schedule for the study is presented in Section 6.

---

## **2 PROBLEM DEFINITION**

### **2.1 Statement of the Problem**

The hydrodynamic model would be improved with Site-specific river current information, which can be used to verify model calibration at the Site. The model would be further improved with an updated bathymetry survey.

The bathymetry of the Site has some recognized inaccuracies that were noted during visual inspections made at low river stages. These inaccuracies occur because the existing Site bathymetry was collected on widely-spaced transects taken in the early stages of the reconnaissance investigation and missed key shoreline features at the Site.

### **2.2 Primary Objectives of Study**

The main goal of the work discussed in this SAP is to collect site-specific data to support the TCRA.

The hydrodynamic model will be used to establish the expected flow-related forces acting on the submerged Site stabilization features that are constructed for the TCRA. The hydrodynamic model will provide insight into specific hydrodynamic processes at the Site.

This model will also be used to answer questions related to episodic high-flow events in the San Jacinto River and storms (e.g., hurricanes):

- What size of material will resist erosion during high-flow events or storms?
- What is the potential depth of scour related to high-flow events, and where would this scour potentially occur?

The bathymetric data will be used to update the hydrodynamic model, and to provide a more accurate base map for use in the TCRA design.

---

### 3 MODELING FRAMEWORK AND APPROACH

Conducting a hydrodynamic modeling study will produce information that reliably represents current and future conditions at the Site and that can be used for decision-making. The development of a hydrodynamic model will make it possible to understand the river flow and velocity conditions at the Site under a variety of scenarios. In addition, the models can be used to quantitatively evaluate the effectiveness of potential removal actions.

The bathymetry data will be used both in the hydrodynamic model, and to provide an updated base map for the TCRA design.

#### 3.1 Description of Modeling Framework

The hydrodynamic model simulates the movement of water in the San Jacinto River, and accounts for the effects of the following factors on water movement: freshwater inflow from upstream of the Study Area; tides; spatially variable bathymetry and geometry; and estuarine circulation resulting from density differences between seawater and freshwater. The hydrodynamic model is used to simulate temporal and spatial changes in water depth, current velocity, and bed shear stress.

The hydrodynamic model that will be applied in this study is the Environmental Fluid Dynamics Code (EFDC), which is supported by USEPA. EFDC is a three-dimensional hydrodynamic model capable of simulating time-variable flow in rivers, lakes, reservoirs, estuaries, and coastal areas. The model solves the conservation of mass, momentum, and salt equations, which are the fundamental equations governing the movement of water in an estuary. The effects of density-driven processes on circulation in an estuary, such as the San Jacinto River, are incorporated into EFDC. In addition, the model includes a sophisticated turbulence closure algorithm that simulates the effects of vertical turbulence on estuarine circulation. A characteristic of EFDC that is of importance for this study is the flooding-drying feature, which makes it possible to realistically simulate the flooding and drying of inter-tidal areas caused by tidal action in the study area. The model has been applied to a wide range of environmental studies in large number of rivers, estuaries, and coastal ocean areas. A complete description of the model is given in Hamrick (1992).

### **3.2 Hydrodynamic Modeling**

The primary objective of the hydrodynamic data collection is to improve the calibration of the hydrodynamic model. The main tasks that will be conducted during this phase are:

- Compile and analyze available data related to hydrology and hydrodynamics
- Conduct field studies to support modeling study
- Analyze hydrodynamic data
- Update the hydrodynamic model
- Use the hydrodynamic model to refine TCRA design criteria

---

## 4 DATA GAPS AND DATA QUALITY OBJECTIVES

### 4.1 Data Gaps and DQOs

Development of the hydrodynamic model, which includes construction of the numerical grid, will require the following types of Site-specific data:

- Bathymetry and geometry of the San Jacinto River and banks
- Freshwater inflow from the San Jacinto River (upstream boundary) and tributaries
- Water surface elevation and salinity at the downstream boundary

Calibration and validation of the hydrodynamic model will require the following data:

- Current velocities (magnitude and direction)
- Water surface elevation
- Salinity

A review of available data for the Site indicates that the following data gaps exist:

- Bathymetry in the regions located upstream and downstream of the waste impoundments area
- Calibration data, including current velocity, water surface elevation, and salinity

Sources of data and information to meet the other needs of the hydrodynamic model are listed in Table 1.

**Table 1**  
**Data Sources for Hydrodynamic Model Development and Calibration**

| Data Need   | Data Sources   |
|---|--|
| Bathymetry and geometry   | National Oceanic and Atmospheric Administration (NOAA) Nautical Chart bathymetry data; bathymetry data collected during 2009 in vicinity of waste impoundments |
| Freshwater inflow from San Jacinto River                        | Coastal Water Authority discharge at Lake Houston dam; U.S. Geologic Survey (USGS) gauging stations on San Jacinto River                                       |
| Water surface elevation and salinity at the downstream boundary | NOAA tidal gauge station at Battleship Texas State Park  |

The DQOs for the hydrodynamic model development and calibration are:

- Obtain water surface elevation, current velocity, and salinity data in general accordance with U.S. Geologic Survey (USGS) Report 2005-5183 (Quality Assurance Plan for Discharge Measurements Using Acoustic Doppler Current Profilers) using an ADCP equipped with a conductivity, temperature, and depth (CTD) sensor.
- Obtain bathymetry data in general accordance with U.S. Army Corps of Engineers (USACE) Hydrographic Survey Manual EM 1110-2-1003 (January 2002). These data will be used to realistically represent the geometry of the Site in the model and will have the following characteristics:
  1. Horizontal and vertical data acquisition to sub-meter accuracy
  2. Data obtained relative to HGSCD 33 TSARP monument
  3. Data reproduced in U.S. feet within Texas South Central NAD 83 (horizontal) and NAVD 88 (vertical) coordinate systems.

---

## 5 FIELD STUDIES TO SUPPORT TCRA DESIGN

The data gaps described in Section 4 will be fulfilled by conducting various field studies to collect hydrodynamic and bathymetric data. A summary of the field studies to support the modeling study is provided in Table 2.

**Table 2**  
**Potential Field Studies to Support Modeling Study**

| Model        | Data Gap  | Type of Field Study                |
|--------------|---|------------------------------------|
| Hydrodynamic | Current velocity, water surface elevation, salinity | Deployment of ADCP with CTD sensor |
| Hydrodynamic | Bathymetry at the Site                              | Bed elevation along transects      |
| TCRA Design  | Bathymetry at the Site                              | Bed elevation along transects      |

### 5.1 Sampling Procedures

The field tasks described in the sections below will follow procedures described in the SAP (Anchor QEA and Integral 2010) that has been previously submitted and approved by USEPA. Additional field procedures not included in that SAP are provided in this document.

### 5.2 Data Validation and Usability, Analytical Methods, and Quality Control

As part of the RI/FS, data generation and acquisition procedures were described in the SAP (Anchor QEA and Integral 2010). Laboratory and analytical methods were described in Section 2.4 of the SAP; quality control procedures to be followed in the field and by selected laboratories were described in Section 2.5 of the SAP; and data validation and usability were discussed in Section 4 of the SAP. Additionally, quality assurance/quality control procedures are discussed and/or referenced in this SAP as needed.

### 5.3 Field Studies

The two tasks discussed below were developed to support the design of the TCRA. Data developed during these tasks will also be used to support future work to answer additional study questions and in development of remedial alternatives for the Site.



### **5.3.1 Current Velocity Study**

Anchor QEA will deploy one ADCP equipped with a CTD sensor in the vicinity of the waste impoundments within the Site in at least 6 feet of water depth and record data continuously or every 15 minutes. Figure 2 depicts the proposed ADCP deployment location. The ADCP will be deployed for a 1-month period. It is envisioned that at least two high-flow events will occur during this period. If two high-flow events do not occur during the 1-month period, then the sampling will be extended until the desired number of high-flow events has occurred. The mean flow rate in the San Jacinto River is 2,200 cubic feet per second (cfs), and high-flow events with return periods of 2, 10, and 100 years correspond to flow rates of 31,600, 107,000, and 329,000 cfs, respectively. For the purposes of the current velocity study, a high-flow event will be considered to be an event with a peak flow rate of 10,000 cfs or greater. If the magnitude of high-flow events during the data collection period does not reflect a suitable range of conditions (as determined by the project technical team) or if baseline conditions are not re-established between events to sufficiently identify distinct events, the data collection period may be extended on a bi-weekly basis.

The ADCP uses a type of sonar technology that measures and records water current velocities over a range of depths. An ADCP transmits sound bursts into the water column and suspended particles carried by water currents produce echoes (from these sound bursts). These echoes are “heard” by the ADCP with echoes arriving later, from deeper in the water column, assigned greater depths in the echo record. This allows the ADCP to form vertical profiles of current velocity. The ADCP senses water movement in four orthogonal directions simultaneously, with particles within the current flow moving towards the instrument exhibiting different frequencies from those moving away. This process is known as the Doppler shift, which enables the precise measurement of current speed and direction.

ADCP units have been commercially available for over 25 years and are being used in a variety of industries including oceanography, meteorology (used in weather forecasting), shipping (to monitor tides/currents for optimizing shipping in busy ports), and monitoring applications related to sewer and stormwater monitoring. Within the environmental engineering field, ADCPs have been deployed by the USACE for use as part of model development and calibration for determining dispersion of dredged materials from plumes emanating from dredge sites (i.e., USACE SSFATE model). Additionally, the USGS has been

employing ADCPs since 1985 for measuring stream flow in rivers. A Quality Assurance Project Plan (QAPP) for using these instruments when deployed from research vessels has been developed by the USGS (2005) and will be followed during this project where applicable.

The unit deployed will be a Workhorse ADCP manufactured by Teledyne RDI; a datasheet for the Workhorse ADCP is included in Attachment A for reference. This unit is capable of long-term data logging and will be equipped with a CTD. Both the ADCP and CTD data will be recorded in the internal memory of the ADCP. The location of the ADCP/CTD will be surveyed by Anchor QEA staff or a subcontractor, and a reference location will be established to convert changes in water depth measurements to elevations. The location and elevation information will be given in Texas South Central NAD 83/NAVD 88 coordinate system.

The ADCP/CTD will be deployed and operated following manufacturer's instructions and applicable guidance (USGS 2005). An appropriate interval for downloading data and performing systems checks will be determined from the operating manual.

### **5.3.2 Bathymetric Survey**

A bathymetric survey of the Site will be completed by a subcontractor to map the topography and features of the river bed. In addition to the modeling study, the bathymetric survey data will be used for design of the TCRA and provide information about water-based access to the site. Figure 3 depicts the area of proposed survey coverage.

The bathymetric survey will be performed using electronic survey techniques for both horizontal and vertical data acquisition and will be overseen by a hydrographer who is certified by the American Congress on Surveying and Mapping. At a minimum, the contractor will use a survey-grade echo sounder, operating at 200 KHz, coupled with a positioning system capable of providing sub-meter positioning accuracy. Both the echo sounder and horizontal positioning system data will be collected real-time and use software designed for hydrographic survey data acquisition (i.e., Hypack, HydroPro). The contractor will prepare a survey transect plan that will be sufficient to properly represent the Site

bathymetry and geometry, and will provide water depths to show an access channel from the north for the contract documents.

The bathymetric survey will have sufficient areal coverage to produce a 3-foot by 3-foot grid surface from the bed elevation data obtained during the survey. The contractor will prepare a survey transect plan that will be sufficient to meet this requirement. Cross-channel transects will be continuous, with XYZ data provided at 5-foot intervals in the data files. All survey procedures, data collection equipment, methods, densities and equipment calibration for this survey will follow the criteria of the Navigation and Dredging Support Surveys for soft bottom materials as given in the USACE Hydrographic Survey Manual EM 1110-2-1003 (January 2002). The survey will be performed using electronic survey techniques for both horizontal and vertical data acquisition and results will be mapped relative to HGCSO 33 TSARP monument (published elevation 26.57 NAVD88). The water elevation at the survey location will be monitored during the duration of the survey and all echo sounder data will be reduced by the water elevation readings taken during the survey.

The XYZ data gathered will be processed to produce a 3-foot by 3-foot grid surface of the study area and survey transects data. This will be done via development of a three-dimensional model of the data using a software package such as Trimble's "Terramodel" or a similar software suite. The survey will provide sufficient data density to facilitate model generation through the use of break lines to link points of similar elevation (e.g., following contours). This will allow the hydrographer to guide the model development along areas of similar bed elevation based upon the XYZ data and published NOAA navigation charts. Once the model has been developed, it will be compared to the collected data to ensure that the model properly reflects the river topography. After the completion of the quality control check, the completed model will be used to generate an ASCII XYZ grid file that contains bed elevation data on a grid with 3-foot by 3-foot resolution.

Figure 3 presents the area for updated bathymetric survey data.

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## 6 SCHEDULE

It is anticipated that task-specific activities discussed above will require approximately 2 weeks from approval of the TCRA Alternatives Analysis. Following these planning activities, the various data collection events will be implemented, each lasting approximately 1 month, resulting in a total of 6 weeks to implement the study. This anticipated schedule does not account for unforeseen events such as weather delays or interim agency involvement.

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## 7 REFERENCES

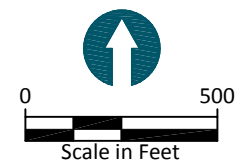
- Anchor QEA, 2010. *Draft - Sampling and Analysis Plan Addendum Chemical Fate and Transport Modeling Study San Jacinto River Waste Pits Superfund Site*. Prepared for McGinnes Industrial Maintenance Corporation, International Paper and USEPA, Region 6. May 2010.
- Anchor QEA and Integral, 2010. *Draft Remedial Investigation/Feasibility Study Work Plan, San Jacinto Waste Pits Superfund Site*. Prepared for McGinnes Industrial Maintenance Corporation, International Paper and USEPA, Region 6. March 2010.
- Hamrick, J.M. 1992. *A Three-Dimensional Environmental Fluid Dynamics Computer Code: Theoretical and Computational Aspects*. College of William and Mary, Virginia Institute of Marine Sciences. Special Report 317. 63 pp.
- USACE, 2002. *Hydrographic Survey Manual EM 1110-2-1003*. January 2002.
- U.S. Geological Survey (USGS), 2005. *Quality Assurance Plan for Discharge Measurements Using Acoustic Doppler Current Profilers*. USGS Report 2005-5183.

## FIGURES

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SOURCE: Google Map Pro 2009





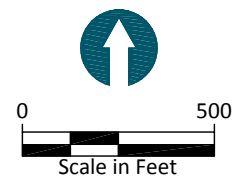
K:\Jobs\090557-San Jacinto\090557-01 - San Jacinto\090557-01-RP-039.dwg FIG 2



**LEGEND:**

● Proposed ADCP Location

**SOURCE:** Google Map Pro 2009



**Figure 2**  
ADCP Deployment Location  
SJRWP TCRA




K:\jobs\090557-San Jacinto\090557-01 - San Jacinto\09055701-RP-039.dwg FIG 3

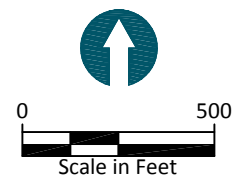
May 27, 2010 4:46pm cdavidson



**LEGEND:**

 Bathymetric Survey Area (73 Acres)

**SOURCE:** Google Map Pro 2009



ATTACHMENT A  
DATASHEET FOR TELEDYNE  
WORKHORSE ADCP

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# Workhorse Sentinel

SELF-CONTAINED 1200, 600, 300 kHz ADCP

## The Global Leader in High-accuracy Data Collection



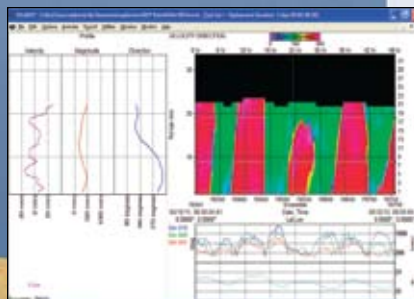
### The Workhorse Sentinel offers:

- **Versatility:** *Direct reading or self-contained, moored or moving, the Sentinel provides precision current profiling data when and where you need it most.*
- **A solid upgrade path:** *The Sentinel has been designed to grow with your needs. Easy upgrades include pressure, bottom tracking, and directional wave measurement.*
- **Precision data:** *Teledyne RDI's patented BroadBand signal processing delivers very low-noise data, resulting in unparalleled data resolution and minimal power consumption.*
- **A four-beam solution:** *Teledyne RDI's patented 4-beam design improves data reliability by providing a redundant data source in the case of a blocked or damaged beam; improves data quality by delivering an independent measure known as error velocity; and improves data accuracy by reducing variance in your data.*

The self-contained **Sentinel** is Teledyne RD Instruments' most popular and versatile Acoustic Doppler Current Profiler (ADCP) configuration, boasting thousands of units in operation in over 50 countries around the world.

By providing profiling ranges from 1 to 165m, the high-frequency Sentinel ADCP is ideally suited for a wide variety of applications. Thanks to Teledyne RDI's patented Broadband signal processing, the Sentinel also offers unbeatable precision, with unmatched low power consumption, allowing you to collect more data over an extended period.

The lightweight and adaptable Sentinel is easily deployed on buoys, boats, or mounted on the seafloor. Real-time data can be transmitted to shore via a cable link or acoustic modem, or data can be stored internally for short or long-term deployments. The Sentinel is easily upgraded to include pressure, bottom tracking, and/or directional wave measurement—for the ultimate data collection solution.



**TELEDYNE**  
**RD INSTRUMENTS**

A Teledyne Technologies Company

# Workhorse Sentinel

SELF-CONTAINED 1200, 600, 300 kHz ADCP



## Technical Specifications

### Water Profiling

| Depth                   | Typical Range <sup>2</sup> 12m |                               | Typical Range <sup>2</sup> 50m |                               | Typical Range <sup>2</sup> 110m |                               |
|-------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|---------------------------------|-------------------------------|
| Cell Size <sup>1</sup>  | 1200kHz                        |                               | 600kHz                         |                               | 300kHz                          |                               |
| Vertical Resolution (m) | Range <sup>3</sup> (m)         | Std. Dev. <sup>4</sup> (cm/s) | Range <sup>3</sup> (m)         | Std. Dev. <sup>4</sup> (cm/s) | Range <sup>3</sup> (m)          | Std. Dev. <sup>4</sup> (cm/s) |
| 0.25m                   | 11–14                          | 12.9                          |                                |                               |                                 |                               |
| 0.5m                    | 13–16                          | 6.1                           | 39                             | 12.9                          | see note <sup>1</sup>           |                               |
| 1m                      | 14–18                          | 3.0                           | 43                             | 6.1                           | 92–71                           | 12.8                          |
| 2m                      | 15–20 <sup>2</sup>             | 2.0                           | 47                             | 3.0                           | 102–78                          | 6.1                           |
| 4m                      | see note <sup>1</sup>          |                               | 52 <sup>2</sup>                | 2.0                           | 113–86                          | 3.0                           |
| 8m                      |                                |                               |                                |                               | 126–95 <sup>2</sup>             | 2.0                           |

<sup>1</sup> User's choice of depth cell size is not limited to the typical values specified.

<sup>2</sup> Longer ranges available.

<sup>3</sup> Profiling range based on temperature values at 5°C and 20°C, salinity = 35ppt.

<sup>4</sup> BroadBand mode single-ping standard deviation (Std. Dev.).

## Long Range Mode

|         | Range (m) | Depth Cell Size (m) | Std. Dev. (cm/s) |
|---------|-----------|---------------------|------------------|
| 1200kHz | 24        | 2                   | 3.8              |
| 600kHz  | 70        | 4                   | 4.2              |
| 300kHz  | 165       | 8                   | 4.2              |

## Profile Parameters

### Velocity accuracy:

- **1200, 600:** 0.3% of the water velocity relative to the ADCP  $\pm 0.3\text{cm/s}$
- **300:** 0.5% of the water velocity relative to the ADCP  $\pm 0.5\text{cm/s}$

### Velocity resolution: 0.1cm/s

Velocity range:  $\pm 5\text{m/s}$  (default)  
 $\pm 20\text{m/s}$  (maximum)

Number of depth cells: 1–128

Ping rate: 2Hz (typical)

## Echo Intensity Profile

Vertical resolution: Depth cell size

Dynamic range: 80dB

Precision:  $\pm 1.5\text{dB}$

## Transducer and Hardware

Beam angle: 20°

Configuration: 4-beam, convex

Internal memory: Two PCMCIA card slots; one memory card included

Communications: Serial port selectable by switch for RS-232 or RS-422. ASCII or binary output at 1200-115,200 baud.

## Standard Sensors

Temperature (mounted on transducer):

Range: -5° to 45°C

Precision:  $\pm 0.4^\circ\text{C}$

Resolution: 0.01°

Tilt: Range:  $\pm 15^\circ$

Accuracy:  $\pm 0.5^\circ$

Precision:  $\pm 0.5^\circ$

Resolution: 0.01°

Compass (fluxgate type, includes built-in field calibration feature):

Accuracy:  $\pm 2^\circ$ <sup>5</sup>

Precision:  $\pm 0.5^\circ$ <sup>5</sup>

Resolution: 0.01°

Maximum tilt:  $\pm 15^\circ$

<sup>5</sup>  $\pm 1.0^\circ$  is commonly achieved after calibration

## Power

External DC input: 20–50VDC

Internal battery voltage: 42VDC new;  
28VDC depleted

Battery capacity: @0°C: 450 watt hours

## Environmental

Standard depth rating:

200m; optional to 6000m

Operating temperature: -5° to 45°C

Storage temperature\*: -30° to 60°C

Weight in air: 13.0kg

Weight in water: 4.5kg

\* Without batteries

## Software

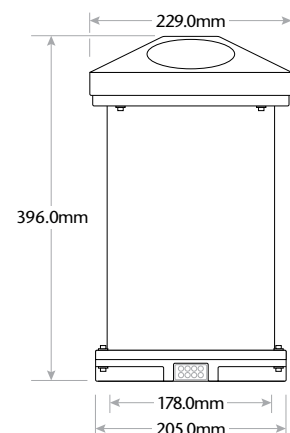
Teledyne RDI's Windows™-based software included:

- WinSC—Data Acquisition
- WinADCP—Data Display and Export

## Available Options

- Memory: 2 PCMCIA slots, total 4GB
- Pressure sensor
- External battery case
- High-resolution water-profiling modes
- Bottom tracking
- AC/DC power converter, 48VDC output
- Pressure cases for depths up to 6000m
- Directional Wave Array

## Dimensions



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Les Nertieres 5 Avenue Hector Pintus 06610 La Gaude France

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Harris County

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**HCPHES**

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**Public Health & Environmental Services**

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107 N. Munger  
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Fax: (713) 477-8963

July 6, 2010

Mr. Valmichael Leos  
Remedial Project Manager  
U.S. Environmental Protection Agency (EPA) - 6SF-RL  
1445 Ross Avenue  
Dallas, TX 75202

Subject: San Jacinto River Waste Pits Superfund Site – Comments on Draft Time Critical Removal Action Alternatives Analysis

Dear Mr. Leos:

Harris County appreciates the opportunity to comment on the Draft Time Critical Removal Action Alternatives Analysis for the San Jacinto River Waste Pits Superfund Site (SJRWPSS) located in Harris County, Texas. Harris County's SJRWPSS Technical Team comprises members of Harris County Public Health and Environmental Services (HCPHES), Public Infrastructure Department and the County Attorney's Office. We received the analysis on June 2, 2010 and submitted initial comments per your deadlines on June 11, 2010. As we stated in our letter of June 11, our review is ongoing and we may choose to supplement. By this letter, we are adding to and modifying our comments based on further discussion with you and others since the time of the prior letter.

As the lead agency, we encourage EPA to choose an alternative that is the safest, environmentally protective, and will at the same time achieve the time critical removal action quickly. In that light, we offer the following comments for your consideration:

1. As we stated in our letter to you dated May 17, 2010 on the initial, preliminary Time Critical Removal Actions (TCRA), we note that standard design practices require structures whose failure would adversely affect human health or the environment to be built so as not to be adversely impacted by a 100-year flood event. We urge at this point that the EPA require the design criteria of the time critical containment be set at a 100-year flood event (1%) at a minimum or higher. The design should take into consideration both the water surface elevation and river's flow velocity for that design event. The 100-year (1%) floodplain elevation in the area of this Site ranges from under 13 feet to almost 14 feet (NAVD 1988). See attached portions of the current FEMA Flood Insurance Rate Map (FIRM) for reference. The current draft analysis under review proposes to design to the 10-year flood event. Please be aware that there have been 3 flood and storm surge



events in this watershed in the past 30 years that have exceeded or were near the 100-year flood level (Hurricanes Alicia and Ike, and the flood of October 1994), and the current hurricane season is projected to be worse than average. When the storm surge probability is factored into flooding events, the actual flood event probability is greater (more severe). We again urge, for the sake of human health and the environment, that this time critical removal action be designed to meet or exceed 100-year flood elevation and velocity.

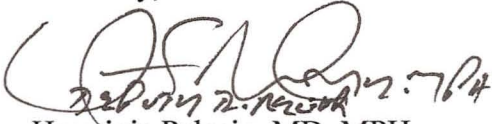
2. Transport of dioxin contamination on colloid particles and in pore water does not seem to be a consideration in the design alternative analysis. This is indicated by the proposal of use of weep holes in the sheet piling and use of geotextiles under aggregate. Through review of reports and discussions on dioxin transport, we believe that attention to transport of dioxin in pore water and on colloid particles is an important transport mechanism to consider in containment alternative considerations. This is observed by review of the following reports and discussions:
  - a. Barth, Ed, Environmental Protection Agency, Cincinnati, Ohio. Personal communication on June 30, 2010, concerning EPA guidance in development on transport of organics and metals on colloidal particles.
  - b. Hofmann T., Wendelborn A. (2007): Colloid Facilitated Transport of Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans (PCDD/Fs) to the Groundwater at Ma Da Area, Vietnam. *Environmental Science and Pollution Research*. DOI: <http://dx.doi.org/10.1065/espr2007.02.389> (Abstract at: <http://www.ncbi.nlm.nih.gov/pubmed/17668815>. A longer report on this study appears at: [http://www.davifo.dk/userfiles/file/pdf\\_ao/AO\\_Env-Sci-Pol.Res\\_groundwater-Ma-Da.Vietnam.pdf](http://www.davifo.dk/userfiles/file/pdf_ao/AO_Env-Sci-Pol.Res_groundwater-Ma-Da.Vietnam.pdf).)
  - c. Louchouart, Patrick and Brinkmeyer, Robin (October 2009). Project citation: Impacts of Dredging Activities on the Fate of Dioxin in the Houston Ship Channel and Evaluation of Natural Remediation Processes.

Incorporation of a geomembrane into the containment design will assist in containing chemicals of potential concern (COPCs) on the site by controlling movement in water.

3. We suggest that the Time Critical Removal Action use an approach primarily of Alternative 3 (as defined by the Draft Time Critical Removal Action Alternatives Analysis) with three refinements: a) conduct the dredge removal in the northwest corner as proposed in Alternative 5; b) substitute a geomembrane for the geotextile under the granular cover; and c) add boat navigation signs of some type posted on the submerged portions of the 1966 perimeter to warn boat traffic to avoid the area due to grounding; this incorporates the site protective feature of Alternative 4 in an institutional manner without impacting the flow of flood water. Alternative 3 has a low flood profile. Finally, we suggest that this modification of Alternative 3 be subjected to the alternative analysis for verification.

Thank you for the opportunity to provide comments on the Draft Time Critical Removal Action Alternatives Analysis. We look forward to contributing to the Superfund process through future reviews. Should you have questions about these comments, please contact Steve Hupp, HCPHES Administrator – Water and Solid Waste Programs at 713-439-6261 or by email at [shupp@hcpbes.org](mailto:shupp@hcpbes.org).

Sincerely,

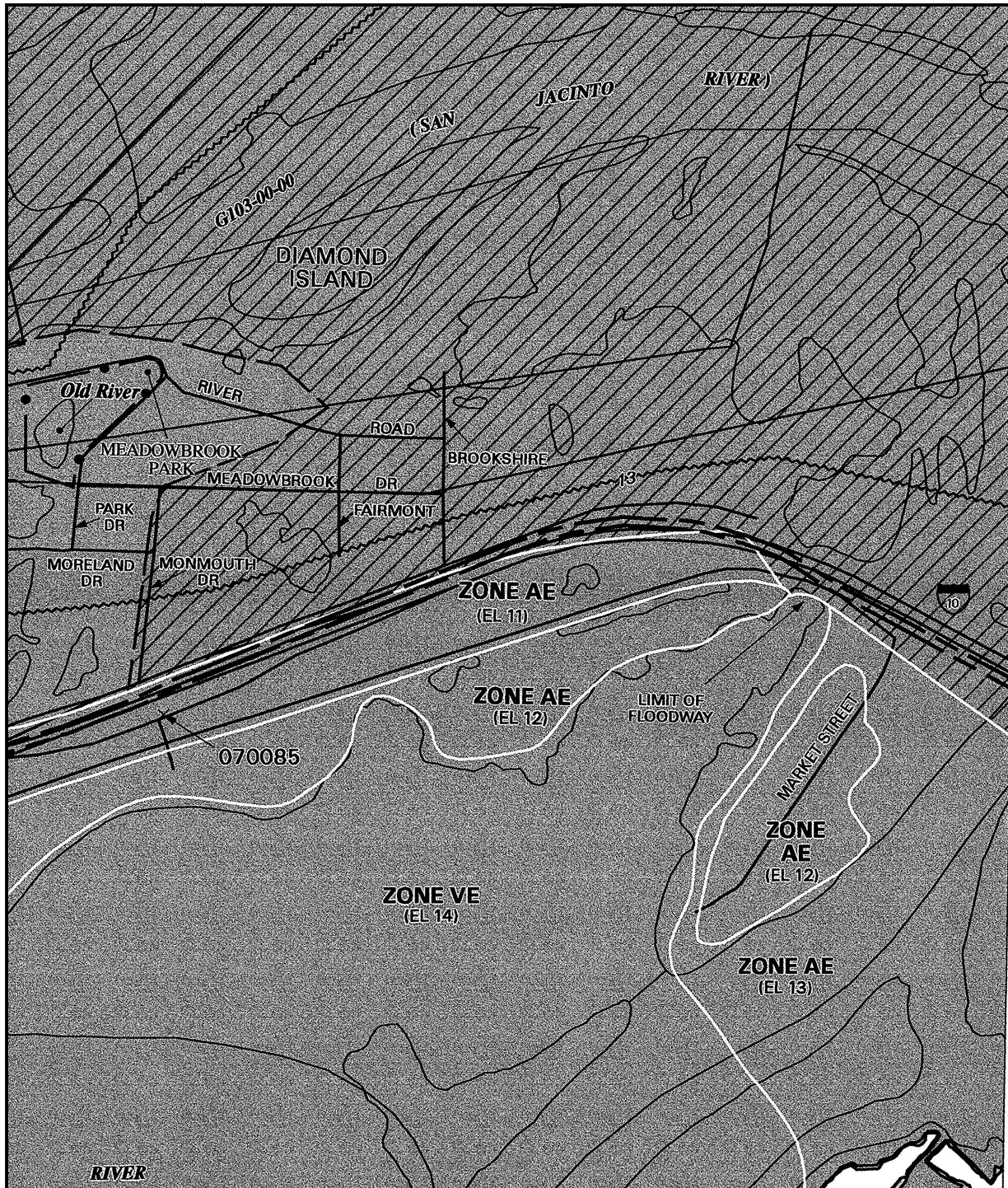
A handwritten signature in black ink, appearing to read 'Herminia Palacio', with a date '2/26/14' written below it.

Herminia Palacio, MD, MPH  
Executive Director

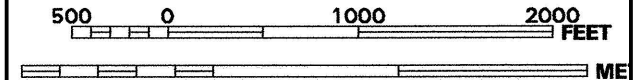
Attachment – FIRM Maps - 2

cc: Ed Emmett, Harris County Judge  
Commissioner Sylvia Garcia, Harris County Precinct Two  
Vince Ryan, Harris County Attorney  
John Blount, P.E., HCPID Architecture and Engineering Division





MAP SCALE 1" = 1000'



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0740L

**FIRM**  
**FLOOD INSURANCE RATE MAP**  
**HARRIS COUNTY,**  
**TEXAS**  
**AND INCORPORATED AREAS**

**PANEL 740 OF 1150**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY                           | NUMBER | PANEL | SUFFIX |
|-------------------------------------|--------|-------|--------|
| HARRIS COUNTY, UNINCORPORATED AREAS | 480287 | 0740  | L      |
| HOUSTON, CITY OF                    | 480286 | 0740  | L      |

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.



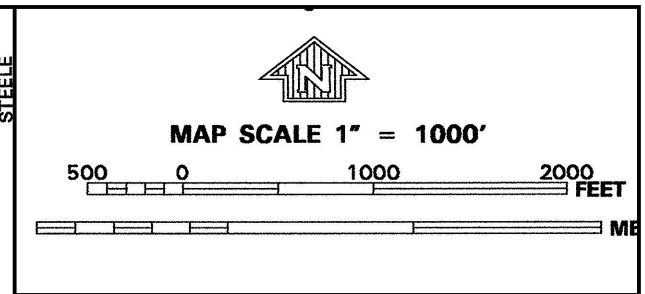
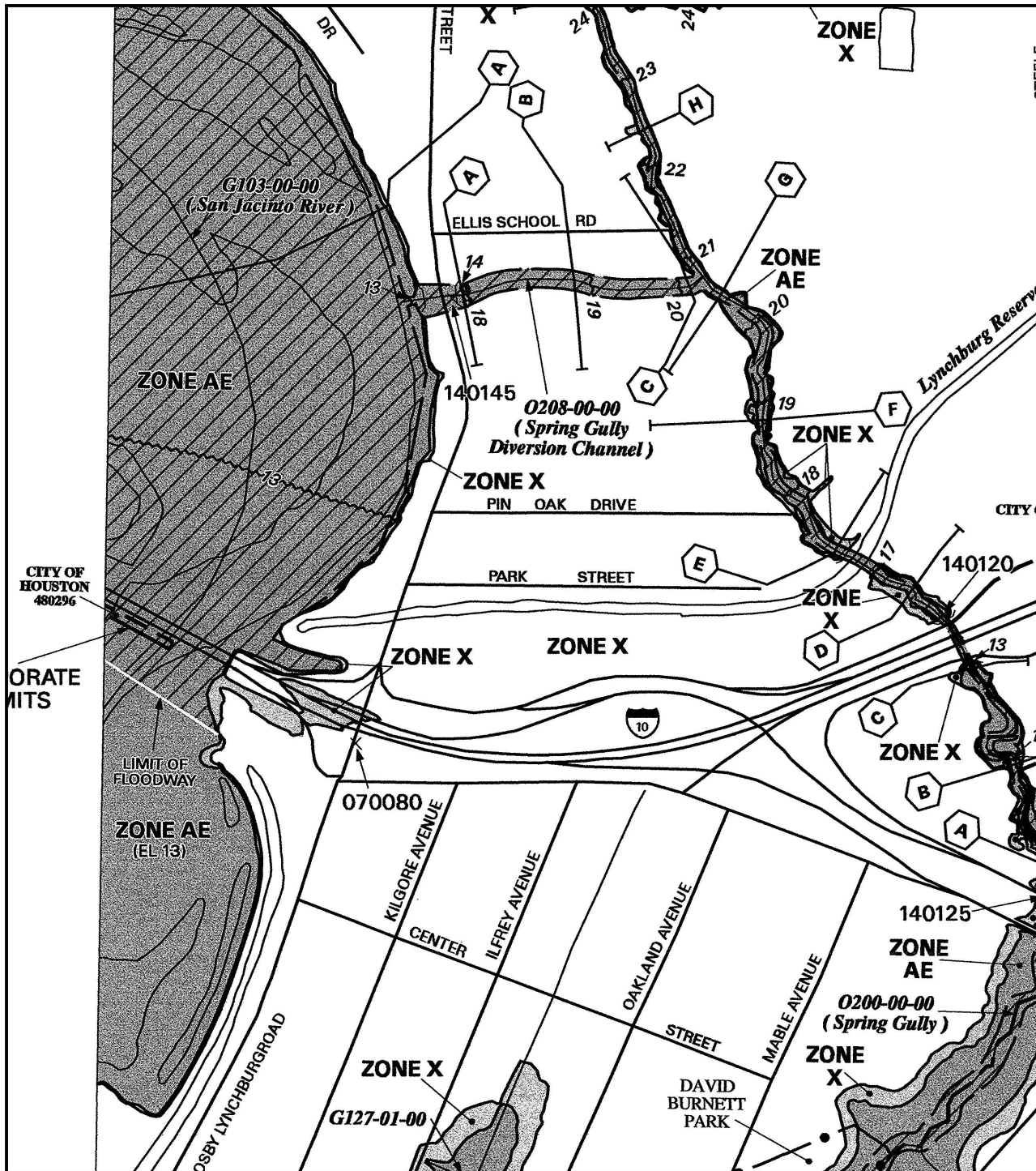
**MAP NUMBER**  
**48201C0740L**

**MAP REVISED:**  
**JUNE 18, 2007**

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at [www.msc.fema.gov](http://www.msc.fema.gov)





NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0745L

# **FIRM** **FLOOD INSURANCE RATE MAP** HARRIS COUNTY, TEXAS AND INCORPORATED AREAS

**PANEL 745 OF 1150**  
 (SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY                           | NUMBER | PANEL | SUFFIX |
|-------------------------------------|--------|-------|--------|
| HARRIS COUNTY, UNINCORPORATED AREAS | 480287 | 0745  | L      |
| BAYTOWN, CITY OF                    | 485456 | 0745  | L      |
| HOUSTON, CITY OF                    | 480296 | 0745  | L      |

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.



**MAP NUMBER**  
**48201C0745L**

**MAP REVISED:**  
**JUNE 18, 2007**

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at [www.msc.fema.gov](http://www.msc.fema.gov)

June 8, 2010

Valmichael Leos  
Remedial Project Manager (RPM)  
Remedial Branch LA, NM, Ok Team  
1445 Ross Avenue, Suite 1200  
Dallas, Texas 75202-2733

Re: *Draft Time Critical Removal Action Alternatives Analysis*, dated May 2010  
San Jacinto River Waste Pits Federal Superfund Site - Comments  
Harris County, Texas

Dear Mr. Leos:

The Texas Commission on Environmental Quality (TCEQ) Remediation Division, Superfund Section has completed the review of the *Draft Time Critical Removal Action Alternatives Analysis* (TCRA) dated May 2010 and received on June 2, 2010. The Draft TCRA was prepared by Anchor QEA, LLC. The TCEQ comments are provided below.

General Comments:

1. Based on the brief review time period allowed for comments, the alternatives analysis presented in the proposed Draft TCRA does not appear to meet the design criteria which the TCEQ typically requires of the state contractors as well as the regulated community.
2. Primarily, the intent to use the 10-year storm event as the design storm event for this site may be unacceptable. The recent 10-year history for major storm events experienced in this area include Tropical Storm Allison (June 2001), Hurricane Katrina (Sept. 2005), and Hurricane Ike (Sept. 2008). Each of these storms were considered a 100-year storm event. The 100-year storm event is routinely used for design criteria for projects in the Houston region to optimize protection of human health and the environment. The TCEQ recommends the use of the 100-year storm event.
3. Regarding the analysis of the proposed alternatives, it is noted that there were no alternatives that proposed using more than one technology (e.g., removal, containment, or treatment). The TCEQ did not see any alternatives that used a

Mr. Valmichael Leos, Remedial Project Manager

Page 2

June 8, 2010

Re: Draft TCRA

combination of the technologies presented in the Draft TCRA, such as containment with removal.

If you have any questions, please contact me at (512) 239-6368 or Phillip Winsor at (512) 239-1054.

Sincerely,

Luda Voskov, P.G., Project Manager  
Superfund Section  
Remediation Division  
Texas Commission on Environmental Quality

LV/LV/cw

cc: Stephen Tzhone, Remedial Project Manager, U.S. EPA, Region 6, Superfund Division (6SF-RA), 1445 Ross Avenue, Suite 1200, Dallas, Texas 75202-2733

Phillip Winsor, Remediation Division, TCEQ  
Garry Beyer, Remediation Division, TCEQ  
Robert Musick, Remediation Division, TCEQ



|             |  |
|-------------|--|
| Houston     | 6120 S. Dairy Ashford Rd.                    |
| Austin      | Houston, TX 77072-1010                       |
| Dallas      | 281.933.7388 Ph                              |
| San Antonio | 281.933.7293 Fax                             |
|             | <a href="http://www.hvj.com">www.hvj.com</a> |

June 30, 2010

Valmichael Leos  
Remedial Project Manager (RPM)  
US Environmental Protection Agency Region 6  
1445 Ross Ave. (6SF-RL)  
Dallas, Texas 75202

Re: Engineering Evaluation  
Proposal TCRA Alternatives Analysis  
San Jacinto River Waste Pits Superfund Site  
HVJ Project No. HG10-14220

This report presents our engineering evaluation of the TCRA Alternatives Analysis Report prepared by Anchor QEA for the San Jacinto River Waste Pits. Our evaluation is intended to provide an independent assessment of the information provided in the report in order to advise EPA on the technical issues involved in the TCRA design. A summary of my recommendations is provided below.

- The general approach as described in Alternative 3 is recommended for the TCRA
- The design should be based on flow velocities and water depths at the site consistent with a 100 year return period flow event in the river.
- Detailed design of the cap should include a filter or geotextile layer.
- The Western Cell should be capped in a similar fashion to the Eastern Cell.
- Detailed design should include the effects of the cap on the flow velocities and river elevations during the design flood event both at and away from the site.

### **Alternative Selection**

After the TCRA is in place the site needs to be either isolated from the river or covered such that inundation does not cause spread of additional contaminated material. Hydrodynamic modeling presented in the Anchor QEA Report Table 1 shows that the flood elevation ranges from about 5 to 9 feet above high water level at the site for return periods of 5 to 25 years. FIRM maps show the 100 year flood at about 12 to 13 feet above normal high water elevations at the site. Complete isolation of the site from floods at these elevations or higher will require construction that substantially reduces the river cross section. Such reduction will cause higher river surface elevations upstream and higher flow velocities near the site. These will potentially increase upstream flooding

and also increase scour at the I-10 Bridge immediately south of the site. In addition, the structures needed to isolate the site are so large as to be a substantial obstacle to any NTCRA removal or treatment options. Therefore, it is not practical for the TCRA to rely on completely isolating the site from flood stage flow events. None of the proposed alternatives include complete isolation of the site for these reasons, although several include partial isolation of the site limited to normal flow conditions.

Since complete isolation is impractical every TCRA alternative includes a cover for the site of some sort. Alternatives 1, 2, and 4 all have structures along the perimeter of the Eastern Cell which impinge on the channel cross section during flood stage events. I recommend the alternative that has the least impact on the overall channel cross section for the TCRA. Alternatives 3 and 5 rely only on cover of the site and are essentially equivalent from this perspective.

In selecting between Alternatives 3 and 5 the main distinction is impacts to the NCTRA work. The removal of the Articulated Concrete Mat proposed for Alternate 5 will be much more difficult than removal the granular cap material proposed for Alternative 3. On this basis I recommend the general approach in Alternative 3, with the stipulations discussed below.

### **Design Storm Event**

Anchor QEA proposes in their alternatives analysis to use a design return period based on the estimated maximum life of the TCRA measures themselves. The fundamental question we need to consider is whether the TCRA design should be based on the life of the TCRA or on broader issues of channel stability. If the TCRA design flood is exceeded we expect erosion at the site to occur, erosion will clearly result in migration of contaminated material offsite. The purpose of the TCRA is to maintain the site stability, and it should be capable of doing so at the same level of effectiveness as a more permanent solution. Guidance for In Situ Sub Aqueous Capping of Contaminated Sediments<sup>1</sup>, Ch. 3 – River/Tidal Current Induced Erosion provides the following guidance for design

*The selection of a design interval should be based on reasonable assumptions. The design life of most civil works projects such as bridges or dams is 50 years. The confidence in ability to predict the forces due to a 50 or 100 year event is high, because of the available data from historic records usually includes events with comparable return intervals. Consideration of events with return intervals in the range of 100 years is therefore appropriate for these types of projects.*

We recommend that the design basis should be a 100 year return period event. Compared to Alternative C as currently proposed by Anchor QEA, this will affect the gradation and thickness of the cover material.

### **Methodology for Evaluating Cover Material**

Anchor QEA's report provides a generalized cover thickness estimate. The design of the cover has two components, sizing the surface layer material for stability during the design flow event was addressed. The ability of a single layer cover material to prevent erosion of site material due to flow within the cover itself was not addressed. Guidance for In Situ Sub Aqueous Capping of Contaminated Sediments<sup>2</sup>, Appendix A Armor Layer Design states the following

*Filters provide an interface between the riprap layer and the protected material and are an essential element for protecting contaminated sediments, particularly poorly consolidated sediments. Filters prevent turbulence and groundwater from moving sediments through the revetment. Filters serve as foundations or load distributors for the riprap for poorly consolidated material which is typical of many contaminated sediments. Filters can be either geotextile, granular, or a combination of the two.*

We recommend that the design should include a filter or geotextile layer as part of the cover design unless the design can be shown to be adequate for preventing erosion of site materials without such a layer.

### **Western Cell Cover**

Anchor QEA proposes in all alternatives to provide erosion protection for the Western Cell that is emergent during normal flow events with existing vegetation, which is to be repaired where disturbed during construction with geotextile and granular cover. This approach cannot assure that all contaminated soils within the cell are contained. A properly designed granular cover with filter or geotextile layer should be installed at the Western Cell.

### **Affects of the TCRA on Flood Flows**

Any material placed at the site will also reduce the river cross section during flood stage increasing at least the perception of the upstream flood and bridge scour risks. The impacts of the proposed filling at the site should be determined by hydrodynamic modeling. Anchor QEA has mentioned this as a data gap in their report in relation to design of the cover material at the site. Guidance for In Situ Sub Aqueous Capping of Contaminated Sediments<sup>3</sup>, Ch. 2 – Hydrodynamic Conditions states the following:

*The presence of an in-situ cap can alter existing hydrodynamic conditions. In harbor areas, or estuaries, the decrease in depth or change in bottom geometry may affect current patterns. In a riverine environment, the placement of a cap, by reducing depths and restricting flows may significantly alter the flow carrying capacity of the channel. Changes in channel geometry may also affect flow velocities, increasing shear stresses on a cap or to opposite or downstream streambanks. Historic flow data may therefore not be adequate to characterize velocities at the capping site. Modeling studies may be required to assess such changes in site conditions due to placement of an in-situ cap.*

We recommend that the hydraulic analysis extend upstream to determine what if any impact there will be on flood level elevations. The analysis should also extend downstream to assess current velocities and any potential increased scour at the I-10 bridge.

If the analysis shows significant impacts to either upstream flood elevations or bridge foundation scour then removal of some site material along the eastern edge of the site may be required to restore present water elevation and flow velocity conditions. Given the limited amount of material to be placed during the recommended TCRA measures we do not expect this to be a problem, but it should be evaluated and impacts mitigated if necessary.

Mr. Valmichael Leos  
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We appreciate the opportunity to work with you on this project. Please let me know if you have any questions or require further information.

**HVJ ASSOCIATES, INC.**

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<sup>1</sup> USEPA (1998) Guidance for In-Situ Subaqueous Capping of Contaminated Sediment. EPA-905-B96-004

<sup>2</sup> *ibid*

<sup>3</sup> *ibid*